

DESCRIPTION OF TWO SQUALODONTS RECENTLY DISCOVERED IN THE CALVERT CLIFFS, MARYLAND;
AND NOTES ON THE SHARK-TOOTHED CETACEANS.

By REMINGTON KELLOGG,

Of the Bureau of Biological Survey, United States Department of Agriculture.

INTRODUCTION.

When the study of paleontology was less advanced than it is at present, any announcement of the discovery of prehistoric animals unlike the living indigenous fauna was usually received with some suspicion. In spite of this distrust, many attempts were made by the early writers to explain the presence of fossil remains of marine mammals in strata above the sea level or at some distance from the seashore. In one of these treatises¹ is found what is, apparently, the first notice of the occurrence of fossil remains referable to shark-toothed cetaceans. The author of this work figures a fragment of a mandible, obtained from the tufa of Malta, which possesses three serrate double-rooted molar teeth.

Squalodonts as such were first brought to the attention of paleontologists in 1840, by J. P. S. Grateloup,² a French naturalist primarily interested in marine invertebrates. In the original description of *Squalodon*, Grateloup held the view that this rostral fragment from Leognan, France, belonged to some large saurian related to *Iguanodon*. Following the announcement of this discovery, Von Meyer³ called attention to the teeth of this fossil, and concluded that the specimen was referable to some flesh-eating cetacean. A year later, Grateloup⁴ concurred in this opinion. One other specimen should be mentioned in this connection, but, unfortunately, its relationships are quite uncertain. This specimen consists of a single tooth which was thought to bear resemblance to some pinniped by Von Meyer⁵ and named *Pachyodon mirabilis*. Although this name has two years' priority over that of Grateloup's it should not be revived in this sense until the tooth is

¹ Scilla, A., *La Vana Specvlazione distingannata dal Senso*, Naples, p. 123, pl. 12, fig. 1, 1670; idem *De Corporibus Marinis Lapidescensibus quae defossa Reperiuntur*, Rome, p. 54, pl. 12, fig. 1, 1759.

² Grateloup, J. P. S., *Actes Soc. Linn. de Bordeaux*, vol. 11 for 1839, No. 56, p. 348, 1840.

³ Meyer, H. von, *Neues Jahrbuch für Mineralogie*, Stuttgart, pp. 587-588, 1840.

⁴ Grateloup, J. P. S., *Idem.*, pp. 567-568, 1841.

⁵ Meyer, H. von, *Idem.*, p. 414, 1848.

compared with those of true squalodonts and our knowledge concerning it supplemented by the acquisition of the additional material.

Since Von Meyer's and Grateloup's time the group has become better known, and its geographic and geologic range widely extended. The most important discoveries in regard to the group since 1840, as well as the best preserved specimens, have been the announcement of *Squalodon antverpiensis* by Van Beneden, 1861, *Rhizoprion* [= *Squalodon*] *bariensis* by Jourdan, 1861, *Squalodon bariensis* [= *zitelli*] by Zittel, 1876-77, *Prosqualodon australis* by Lydekker, 1894, and *Neosqualodon assenzae* by Dal Piaz, 1904.

No records of the occurrence of squalodonts are known to the writer from Africa, Asia, or from the Pacific coast of North America. This seems rather remarkable in view of the fact that a number of forms are known from the Tertiary deposits of Europe, and from similar deposits along the Atlantic coast of North America. Other representatives of this group have been found in Patagonia, Australia, and New Zealand. This peculiar distribution may be explained in part by the inadequacy of our knowledge concerning the Oligocene and Miocene marine formations of Asia and Africa. Although considerable progress has been made in the study of marine invertebrates and land vertebrates of the Pacific coast Province, comparatively little is known concerning its cetacean fauna.

The possibilities for widespread dispersal of the cetaceans are exceptionally great in view of the absence of physical barriers, and the chief controlling factor, apparently, is the food supply. It is fairly well known that some of the larger cetaceans, especially the whalebone whales, perform migrations between definite points. Other cetaceans have been observed only in rather limited areas, and a few forms are known which are restricted to large fresh-water rivers and their estuaries. It is thought that some of the predaceous forms, such as the dolphins, follow the routes of the oceanic currents. In case of the squalodonts which were, judging from their serrate dentition, remarkably well adapted for a predatory life and hence could secure an adequate food supply wherever fish or dolphins were present in sufficient numbers to insure easy capture, one would expect their geographic range to be practically cosmopolitan. Under similar prevailing conditions of aquatic life the distribution of the squalodonts should have been much the same as that of the Killer Whale (*Orcinus*).

In the Northern Hemisphere the squalodonts appear in considerable numbers during the Miocene. Their geological history in this region previous to the Miocene is unsatisfactory, resting as it does upon the occurrence of cetaceans in the Ashley River phosphate beds of South Carolina and upon the discovery of an imperfectly known squalodont of small size in the Upper Oligocene of Germany.

The South Carolina deposits have yielded a relatively large assemblage of cetaceans and a number of these have been referred to as squalodonts. The described forms are: *Ceterhinops longifrons*, and *Squalodon debilis*, *modestus*, *pelagius*, *protervus* Leidy (not Cope), and *tiedemani*. All of these are either from the sands or the phosphate beds of the Ashley River, except *Squalodon tiedemani*, which is from the closely approximate Wando River in the same State. All those referred to *Squalodon*, except *pelagius* and *tiedemani*, are known only from detached teeth. *Squalodon pelagius* is represented by a fragment of the left maxilla bearing a single tooth; its relationships are uncertain. Fragments of the upper and lower jaws of *Squalodon tiedemani*, with teeth, represent all that is known concerning this form. These fragments suggest a cetacean of large size. A restudy of the Ashley fauna has convinced the writer that most of the cetaceans mentioned above are not squalodonts, as will be shown in another part of this review. Two other interesting cetaceans have been obtained from the Ashley phosphate deposits. The only parts known of one of these, *Colophonodon holmesii*, are single-rooted teeth, and the skull of the other, *Agorophius pygmaeus*, is unlike any known squalodont.

The decision as to the age of these fossils necessarily depends upon geological considerations. It is known that there is a thin layer of marl⁶ of Upper Miocene age which overlies the Ashley (Eocene) marl. In this connection it may be well to quote from William H. Dall⁷ regarding the age of these Miocene marls:

I have no hesitation in concluding that the rock from which the phosphate nodules are derived is of Upper Miocene age, or at least that its fauna, while unmistakably Miocene, is more really related to the Chesapeake Miocene than to the older beds of the Chipola Epoch. The phosphatization of the rock was of course later than its formation and perhaps might have taken place like that of the very similar Peace River, Florida, phosphate pebbles, during Pliocene time.

Since many of the fossil cetaceans were obtained from the bed of the Ashley River, it by no means follows that they are all derivatives of those beds which have been determined as Eocene. If these cetaceans were really Eocene forms, then it might be said that the squalodonts had attained a considerable development in North America at that time. We would expect, however, that these supposed Eocene forms would present primitive characters. Unfortunately, the fragmentary condition of some of the remains makes it difficult to form an opinion in this matter. Taken as a whole, they can not be said to be more primitive than those squalodonts conceded to be of Miocene

⁶ Sloan, E., Catalogue of the Mineral localities of South Carolina, Bull. No. 2, ser. 4, South Carolina Geol. Surv., Columbia, pp. 290-292, 469, 1908.

⁷ Dall, W. H., Amer. Journ. Sci., ser. 3, vol. 48, p. 30, 1894.

age. Excepting the genus *Agorophius*, the general statement may be made that no fossil shark-toothed cetaceans have thus far been discovered in North America which are so primitive that they must be regarded as probably older than the Miocene.

As remarked above, the great majority of known squalodonts are from deposits conceded to be of Miocene age. On the basis of the fauna, as represented by the squalodonts, there is no good reason for considering most of the fossil cetaceans derived from deposits in the Ashley River region as older than the Upper Miocene. *Agorophius pygmaeus*, apparently, is derived from deposits of Upper Eocene age, that is, from the Ashley marl. The age of some of the other cetaceans will probably be disputed until some competent geologist obtains additional specimens and reports on their occurrence.

Our present information regarding this group is chiefly the result of accidental discovery of isolated specimens, and our knowledge concerning them should rapidly widen whenever a systematic search is made for their remains in marine formations. The fact that cetaceans are capable of traveling long distances should place them foremost among animals used for correlating widespread deposits. They occur not only in typical marine deposits but in estuaries and river deltas as well. The main difficulty seems to be a morphological one, for we are confronted with the task of determining whether or not a species has a long geologic range. Evolution may have been and probably was extremely slow in modifying the physical characteristics of many of the cetaceans. From the evidence afforded by fossil cetaceans we see that some of the families have no living representatives while some of the genera have made little if any progress since the Miocene so far as skeletal characters are concerned. The squalodonts represent an archaic group which are still imperfectly known and the surviving types probably disappeared before the close of the Pliocene. A possible exception to this statement rests on a record of a squalodont found in association with quaternary land mammals in Italy.

For the privilege of studying the squalodont material in the National Museum I am indebted to C. W. Gilmore and J. W. Gidley. The type of *Squalodon tiedemani* was intrusted to me for study by E. O. Hovey of the American Museum of Natural History at the suggestion of W. D. Matthew. A collection of cetaceans from the Ashley River phosphate deposits, including squalodonts, has been placed in my hands for comparison by R. S. Lull of Yale University. Gerrit S. Miller, jr., has extended facilities for studying the skeletons of living cetaceans. W. L. McAtee has verified a reference for me at Philadelphia and E. A. Preble has kindly read the manuscript. The text figures were drawn by J. R. Malloch and the photographs (pls. 1-4) were retouched by Miss Ludwika Wieser. Furthermore

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Acknowledgments are due to the following for correcting or confirming the age determinations of those forms which occur in their respective countries: Prof. Giorgio Dal Piaz, Museo Geologico dell'Università di Padova, Italy; Prof. Giuseppe Stefanini, Museo Geologico, Firenze, Italy; Dr. Federico Sacco, R. Politecnico, Gabinetto di Geologia, Castello del Valentino, Torino, Italy; Dr. H. Gerth, Rijks Geologisch-Mineralogisch Museum, Leiden, Holland; Prof. Othenio Abel, Paleobiologischer Lehrapparat der Universität, Wien, Austria; and J. McDonald, acting director, Dominion Museum, Wellington, New Zealand. Acknowledgments also are due to George P. Merrill and T. Wayland Vaughan.

Before describing the specimens from the Calvert Cliffs, Maryland, it was necessary to examine most of the literature relating to the animals in question, which had been accumulating during the past 84 years. Since Grateloup recorded the occurrence of *Squalodon* in France nearly 50 names have been proposed for remains of cetaceans which were assumed to be squalodonts at some time after their original publication. A review of these forms follows. It will be noticed that no attempt is made to offer a full bibliography for each species, and that only such references are given as are considered to be pertinent to the present study. In considering their claims to recognition the specific names may best be taken up alphabetically.

NOMENCLATURE.

MICROCETUS AMBIGUUS (Meyer).

Phoca ambigua MUENSTER, G. G. VON, Neues Jahrbuch für Mineralogie, Stuttgart, p. 447, 1835 (*nomen nudum*).—MEYER, H. VON, Beiträge zur Petrefacten-Kunde (herausgeg. von Georg. G. zu Muenster), Bayreuth, vol. 3, p. 1, pl. 7, figs. 1-8, 1840 [Giebel, C. G., Odontographie, Leipzig, pl. 36, figs. 10, 11a, 11b, 14, 1855].—MOLIN, R., Sitzungsber. math.-naturwiss. Cl. Kais. Akad. der Wissenschaften, Wien, vol. 35, No. 8, p. 118, 1859.

Type specimen.—Consists of two one-rooted premolars and two two-rooted molars, a fragment of a rib, and a dorsal vertebra. Type in the "Paläontologische Sammlung" at Munich, Germany.

Type locality.—Found 30 feet below the surface in the Tertiary marl of the Osnabrück Basin near Bünde, Oldenburg, Germany. Upper Oligocene.

Subsequent allocation.—This form belongs in the group of squalodonts characterized by *Neosqualodon* Dal Piaz according to Abel.⁸ The absence of accessory cusps on the anterior cutting edge of the molars⁹ and the shape of those on the posterior edge shows clearly

⁸ Abel, O., Mém. Mus. Roy. Hist. Nat. Belgique, Bruxelles, vol. 3, footnote, p. 66, 1905.

⁹ Meyer, H. von, Beiträge zur Petrefacten-Kunde, vol. 3, pl. 7, figs. 1a, b; 2a, b, c. 3, 1840.

that this form is quite unlike those specimens referred to the genus *Neosqualodon*. The general appearance of these small teeth, including the presence of coarse striae at the base of the enamel crown of the molar as well as the compressed crowns of the premolars,¹⁰ suggest a closer relationship with *Squalodon* than with *Neosqualodon*. Since it does not belong to any previously described genus, it may hereafter be known as *Microcetus ambiguus* (Meyer).

SQUALODON ANTVERPIENSIS Van Beneden.

Squalodon antverpiensis VAN BENEDEN, P. J., Bull. Acad. Roy. Sci., des Lettres et des Beaux-Arts, Bruxelles, ser. 2, vol. 12, No. 7, p. 28, 1861; Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, pp. 14-43, pl. 1, 1865.

Type specimen.—Consists of the major portion of a fragmentary rostrum with teeth in situ—that is, three premolars and seven molars. This species has a long symphysis, as is shown by the two fragments of the mandible belonging to the type. Additional material provisionally assigned to the species includes several cervical vertebrae, a clavicle, humerus, cubitus, and phalanx. Type in the "Musée Royal d'Histoire Naturelle de Belgique," at Brussels, Belgium.

Type locality.—Fort No. 4, at Vieux-Dieux, in the vicinity of Antwerp, Belgium. The type comes from the "Sables inférieurs d'Anvers" which according to Abel¹¹ are referable to the Bolderian or Upper Miocene.

Subsequent allocation.—A few years later Van Beneden¹² described and figured a portion of the symphysial region of the lower jaws of a second squalodont derived from the deposits around Antwerp. This specimen possesses premolars exhibiting sawlike cutting edges and the enamel crowns of the teeth are fluted or ornamented with large coarse striae similar to the ornamentation on the incisors of the type specimen. On the whole there is considerable resemblance between the teeth of the two specimens, and Van Beneden was undoubtedly right in referring them to the same species.

The descriptions and figures of Van Beneden are probably inexact in many respects for several discrepancies are to be observed in the account as given by Abel¹³ and as drawn up by Van Beneden.

NEOSQUALODON ASSENZAE Dal Piaz.

Neosqualodon assenzae DAL PIAZ, G., Abhandl. Schweiz. Paläont. Ges. Geneve, vol. 31, No. 5, pp. 1-19, with 1 pl., figs. 1a, 1b, 2, 3a, 3b, 4a, 4b, 5a, 5b, 6a, 6b, 1904.

Type specimen.—Consists of a posterior fragment of the rostrum (the tip of rostrum and the brain case posterior to narial openings

¹⁰ Meyer, H. von, Beiträge zur Petrefacten-Kunde, vol. 3, pl. 7, figs. 4a, b; 5a, b, 1840.

¹¹ Abel, O., Mém. Mus. Roy. Hist. Nat. Belgique, Bruxelles, vol. 1, p. 42, 1901; vol. 3, p. 50, 1905.

¹² Van Beneden, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 37, pp. 1-13, pl. —, figs. 1-2, 1868.

¹³ Abel, O., Mém. Mus. Roy. Hist. Nat. Belgique, Bruxelles, vol. 3, pp. 47-50, 1905.

are wanting) and a fragment of a mandible, both with serrate cheek teeth in situ. The mandible possessed ten, and possibly more, serrate cheek teeth. Type in the "Museo Geologico dell'Istituto superiore di Firenze," Italy.

Type locality.—From white limestone ["calcarea di Ragusa"] of Scicli, near Modica, Sicily. Langhiano superiore, or Lower Miocene.

Subsequent allocation.—The species is quoted by Dal Piaz and is credited to Forsyth-Major without reference or date. This may be a manuscript name of Forsyth-Major, for the name stands: "*Squalodon assenzae* Major (in sched.)."¹⁴

This form apparently is very closely related to *Neosqualodon gas-taldi*.

SQUALODON ATLANTICUS (Leidy).

Macrophoca alantica LEIDY, J., Proc. Acad. Nat. Sci. Philadelphia [vol. 8], pp. 220-221, 1856.

Squalodon atlanticus LEIDY, J., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, pp. 416-418, pl. 28, figs. 4-7, 1869.

Type specimen.—Consists of three molar teeth. Type Nos. 11217, 11218, 11219, Academy of Natural Sciences of Philadelphia.

Type locality.—Miocene marl of Shiloh, Cumberland County, New Jersey. Upper Miocene.

Subsequent allocation.—This species was placed in the genus *Squalodon* by Cope.¹⁵ More recently Allen¹⁶ refers this species to the genus *Basilosaurus*, but gives no reasons. The appearance of these teeth is so unlike the zeuglodonts and resembles so closely the type of teeth that are now regarded as pertaining to the squalodonts, that it is difficult to see on what grounds such an allocation would be based.

PROSQUALODON AUSTRALIS Lydekker.

Prosqualodon australis LYDEKKER, R., Annales del Museo de La Plata, Palaeont. Argentina, vol. 2, for 1893, pp. 8-10, pl. 4, figs. 1, 1a, 1b. April, 1894.

Type specimen.—Consists of a nearly complete skull with teeth in situ. Lydekker¹⁷ states that the roots of the molariform teeth have coalesced, but are defined by a deep groove. He further states that in the structure of the nasals the genus *Prosqualodon* is more generalized than *Squalodon*, while the characters presented by the teeth show it to be more specialized. Type in the "Museo de La Plata," Argentine Republic.

Type locality.—A marine deposit on the coast in the Territory of Chubut, Patagonia, Argentine Republic. The locality was stated more precisely by Ameghino¹⁸ as the Patagonian formation at Port Madryn on Bahia Nueva, Chubut Territory. The Tertiary formation

¹⁴ Dal Piaz, G., Abhandl. Schweiz. Paläont. Ges. Geneve, vol. 31, p. 3, 1904.

¹⁵ Cope, E. D., Proc. Acad. Nat. Sci. Philadelphia [vol. 19], pp. 132, 153-154, 1867.

¹⁶ Allen, G. M., Mem. Boston Soc. Nat. Hist., vol. 8. No. 2, p. 282, 1916.

¹⁷ Lydekker, R., Proc. Zool. Soc. London, p. 921, 1899.

¹⁸ Ameghino, F., Bol. Inst. Geogr. Argentina, vol. 17, p. 99, 1896.

at Port Madryn [New Bay] was considered by Ortmann¹⁹ to belong to the Patagonian beds and he held that these beds are Lower Miocene.

Subsequent allocation.—This skull has been studied quite thoroughly by Lydekker, while Abel²⁰ has figured a restoration of a second skull and discussed its affinities. In discussing the relationships of this genus, Stromer²¹ remarked that according to its organization and geological age, it should rather be named *Postsqualodon*. The mandibles, teeth, vertebrae, tympanic and periotic studied by True²² were collected by the late J. B. Hatcher in the Patagonian beds at San Julian, Santa Cruz Territory.

AGRIOCETUS AUSTRIACUS Abel.

See *Agriocetus incertus* (Brandt).

SQUALODON BARIENSIS BARIENSIS (Jourdan).

Rhizoprion bariensis JOURDAN, C., Comptes Rendus Acad. Sci. Paris, vol. 53, pp. 959, 962, 1861.—LORTET, L., Archiv. Mus. d'Hist. Nat. de Lyons, vol. 4, pp. 315-316, pls. 25 bis-25ter, 1887.

Type specimen.—Original description was based upon a nearly complete skull with teeth in situ. The tip of the rostrum was missing and Jourdan thought that portion was lost or pulverized at the time of collection. However, Gervais later obtained this missing fragment from Matheron and communicated the fact to Van Beneden²³ who published his letter together with a drawing of the same. Type in the "Muséum des Sciences Naturelles" at Lyon, France.

Type locality.—Obtained in a stone quarry at the village of Bari, near Taulignan, not far from Saint-Paul-Trois-Châteaux, Department of Drome, France, from the lower level of a bed of marine limestone. Basal Helvetian²⁴ or Middle Miocene.

Subsequent allocation.—This species was referred to the genus *Squalodon* by Zittel.²⁵ The acquisition of a second specimen of this interesting squalodont, which possesses a nearly complete rostrum and dentition, has so supplemented the data afforded by the mutilated type specimen that little remains unknown concerning the appearance and proportions of the skull. This find was announced by Paquier²⁶ and the specimen was obtained from the quarries of Saint-

¹⁹ Ortmann, A. E., Princeton Patagonian Exped., vol. 4, Palaeontology I, pt. 2, 1901-1906, pp. 275, 285, 297; Berry, E. W., Proc. First Pan-Pacific Sci. Conference held under auspices of Pan-Pacific Union, Special Publ. No. 7, pt. 3, p. 861, Bishop Museum, Honolulu, Hawaii, 1922.

²⁰ Abel, O., Sitzungsber. math.-naturw. Cl. Kais. Akad. der Wissenschaften, Wien, vol. 121, pt. 1, pp. 57-64, pls. 3, 1912.

²¹ Stromer, E. von, Beitr. Pal. und Geol. Oesterr.-Ungarns und d. Orients. Wien, vol. 21, p. 172, footnote, 1908.

²² True, F. W., Smithsonian Misc. Coll. (Quart. Is.), vol. 52, pt. 4, Publ. 1875, pp. 447-455, text figs. 77, 78; pl. 43, fig. 2; pl. 44, figs. 1-8; pl. 45, figs. 1-6, 1909.

²³ Van Beneden, P. J., Bull. Acad. Roy. Sci. Belgique, Bruxelles, ser. 2, vol. 13, No. 5, p. 463, pl. —, (colored), 1862.

²⁴ Deperet, C., Archiv. Mus. Hist. Nat. de Lyon, vol. 4, pp. 278-279, 1887.

²⁵ Zittel, K. von, Palaeontographica, Stuttgart, vol. 24, p. 235, 1876-77.

²⁶ Paquier, V., Mém. Soc. Géol. de France, Paris, Paleontologie, vol. 4, fasc. 4, Memoire No. 12, pp. 12-15, pl. 18, figs. 1-10, 1894.

Paul-Trois-Chateaux, Department of Drome, France. The limestone of formation was assigned to the Burdigalian stage or Lower Miocene.

SQUALODON BARIENSIS BELLUNENSIS Dal Piaz.

Squalodon bariensis JOURDAN, var. *bellunensis* DAL PIAZ, G., *Palaeontographia Italica*, Pisa, vol. 6, p. 312, pls. 26-29, and text fig. 1, 1901.

Type specimen.—Consists of the rostral portion of a skull with eight teeth in situ, and a fragment of a mandible with four teeth. Type probably in the "Museo geologico Giovanni Capellini" at Bologna, Italy.

Type locality.—"Dell'arenaria miocenica di Belluno," Compartment of Venetia, Italy. Langhiano or Lower Miocene.

Subsequent allocation.—This form, judging from the original description and the published figures, is very closely related to, if not identical with, *Squalodon bariensis* (Jourdan).

SQUALODON BARIENSIS LATIROSTRIS Capellini.

Squalodon bariensis JOURDAN, var. *latirostris* CAPELLINI, G., *Mémoire della R. Accademia delle Scienze dell'Istituto di Bologna*, ser. 5, vol. 10, pp. 437-445, pl. (unnumbered), figs. 1-2, 1903. [Vernacular name "latirostre" used in text (p. 445); latinized name *latirostris* forms legend for plate.]

Type specimen.—Consists of a somewhat damaged cranium and two fragments of the rostrum. The occipital, postorbital, and ethmoidal portions of the cranium are either lost or incomplete. A portion of the mandible, fragments of ribs, and some caudal vertebrae belonging to this specimen are mentioned but not figured. Type in the "Museo geologico dell'Istituto dell'Università di Padova," Italy.

Type locality.—"Arenaria calcarifera dei Grumi dei Frati presso l'ospedale di Schio," Compartment of Venetia, Italy. Langhiano or Lower Miocene.

Subsequent allocation.—A study of the figures in the article of Capellini convinces the writer that the relationships of this specimen are with *Squalodon bariensis*. The amount of variation to be expected in skulls of this genus is not known and the acquisition of additional skulls will be needed to confirm the validity of this subspecies.

SQUALODON BORDAE (Gervais).

Delphinus bordae GERVAIS, P., *Zoologie et Paléontologie françaises*, Paris, ed. 1, vol. 1, p. 153, pl. 41, fig. 8 [reversed]; 1848-1852 [based upon *Delphinoides grate-lupi* (part) Pedroni 27].

Squalodon bordae ABEL, O., *Mem. Mus. Roy. Hist. Nat. Belgique*, Bruxelles, vol. 3, pp. 27, 33, 1905.

Type specimen.—Consists of an incomplete mandible without teeth; the posterior end of the mandible including the angle and the condyle as well as the extreme tip are missing. Specimen was formerly in the collection of H. Arnozan, "directeur de l'Asile départemental des aliénés de la Charente-Inférieure," France.

²⁷ Pedroni, P.M., Jr., *Actes Soc. Linn. de Bordeaux*, vol. 14, pp. 107-109, 1845.

Type locality.—"Grès marin?" of Léognan, Department of Gironde, France. Mayencian or Lowermost Middle Miocene.

Subsequent allocation.—Von Meyer²⁸ was the first to suggest that this mandible represents a squalodont, for in his remarks he says that *Delphinus* (*Champsodelphis*) *bordae* Gervais is not a dolphin but is referable to *Squalodon grateloupii* [= *Squalodon typicus*, new species]. In 1900, Abel²⁹ mentioned the specimen and discussed it in connection with *Champsodelphis macrognathus* Brandt. More recently, the same writer³⁰ discussed the dental formula of this specimen in comparison with others, and his account gives one the impression that he considered it a valid species.

ZEUGLONDON BREVICUSPIDATUS (Tate MS.) Hall.

See *Parasqualodon wilkinsoni* (McCoy).

STEREODELPHIS BREVIDENS (Dubreuil and Gervais).

Delphinus brevidens DUBREUIL and GERVAIS, P., Comptes Rendus Acad. Sci. Paris, vol. 28, No. 4, pp. 135-136, January-June, 1849.

Stereodelphis brevidens GERVAIS, P., Zool. et Paléont. françaises, Paris, ed. 1, p. 152, pl. 9, figs. 4-6, 1848-1852; ed. 2, pp. 310-311; Atlas, vol. 5, pl. 9, figs. 4-6, 1859.

Type specimen.—Consists of a fragment of a lower jaw with alveolae, including part of the coronoid process and a portion of the horizontal ramus. Two single-rooted and blunt-crowned teeth were also referred to this species. Type in the "Museum National d'Histoire Naturelle" at Paris, France.

Type locality.—Found in a block of marine limestone that was being used in the construction of new additions to the "Faculte de Medecine" at Paris. Dubreuil and Gervais stated that this stone was obtained from quarries in the vicinity of Castries, to the east of Montpellier, Department of Herault, France. Later, Gervais³¹ published more explicit information, namely, "la molasse dite pierre de Marabel," near Castries. Helvetian or Middle Miocene.

Subsequent allocation.—A new genus *Stereodelphis* was proposed for this species by Gervais. Other writers have considered that it should be referred to the genus *Squalodon*. This species was considered to be a synonym of *Squalodon grateloupii* by Van Beneden,³² while Trouessart³³ placed it in the synonymy of *Squalodon bariensis*. There is reason to believe that this fragment of the lower jaw should be referred to the group characterized by *Eurhinodelphis*. Certain peculiarities are brought out in the figure given by Gervais³⁴ which

²⁸ Meyer, H. von, Palaeontographica. Beiträge zur Naturgeschichte der Vorwelt, Cassel, vol. 6, pp. 42, 47, September, 1856.

²⁹ Abel, O., Denkschriften d. K. Akad. d. Wiss. math.-naturw. Kl., Wien, vol. 68, p. 840, 1900.

³⁰ Abel, O., Mém. Mus. Roy. Hist. Nat. Belgique, Bruxelles, vol. 3, pp. 27, 33, 1905.

³¹ Gervais, P., Zool. et Paléont. franç., Paris, ed. 1, vol. 1, p. 152, 1848-1852.

³² Van Beneden, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, p. 70, 1865.

³³ Trouessart, E. L., Cat. Mamm. viv. foss., Berlin, fasc. 5, p. 1012, 1898.

³⁴ Van Beneden, P. J., and Gervais, P., Ostéographie des Cétacés vivants et fossiles, Paris, p. 435; Atlas, pl. 28, figs. 14, 14a, 1880.

favor such an allocation. The backward extension of the alveolar gutter upon the base of the coronoid, the lack of well-defined septa between the alveolae for the two-rooted molars, and the configuration and general appearance of the fragment as a whole agrees well with *Eurhinodelphis* as represented by material in the United States National Museum.

SQUALODON BURGUETI (Gervais).

Smilocomptus burgueti GERVAIS, P., Comptes Rendus Acad. Sci. Paris, vol. 28, No. 21, p. 645, footnote, January-June, 1849; Zool. et Paléont. franç., Paris, ed. 1, vol. 1, p. 161, pl. 41, fig. 4, 1848-1852.

Type specimen.—Name proposed provisionally for a somewhat flattened caniniform tooth. Type in the "Museum d'Histoire Naturelle" at Bordeaux, France.

Type locality.—Found in a shell marl at Salles, Department of Gironde, France. This shell marl is considered to belong to the Upper Miocene by Tournouer.³⁵ Tortonian or Middle Miocene.

Subsequent allocation.—This species was considered to be a synonym of *Squalodon grateloupii* by Van Beneden.³⁶ More recently, Trouessart³⁷ placed it in the synonymy of *Squalodon bariensis*.

TRIRHIZODON CATULLI (Molin).

Pachyodon catulli MOLIN, R., Sitzungsber. math.-naturw. Cl. Kais. Akad. der Wissenschaften, Wien, vol. 35, No. 8, p. 126, pls. 1-2, 1859.

Type specimen.—This species was based upon 11 teeth, including 8 which have fairly complete crowns, 2 of which are figured as three-rooted, and 3 as two-rooted, as well as 3 other imperfect teeth. G. Dal Piaz has recently informed the writer that Molin's original specimens are now lost. They were formerly in the Museum of the University of Padova, Italy.

Type locality.—"dall'arenaria grigia di Libàno circa due ore al Nord Est. di Belluno," compartment of Venetia, Italy. This breccia was stated by Molin³⁸ to belong to an Eocene formation. This determination is probably incorrect, for De Zigno³⁹ assigns this deposit to the Miocene, and Longhi⁴⁰ as a result of his study of the fossil plants places these breccias in the Aquitanian stage. Langhiano or Lower Miocene.

Subsequent allocation.—This species was placed in the genus *Squalodon* by Brandt.⁴¹ In 1890, Cope⁴² erected a new genus, *Trirhizodon*,

³⁵ Tournouer, R., Actes Soc. Linn. de Bordeaux, ser. 3, vol. 9, pp. 119-161, 1873; Vaughan, T. W., Proc. First Pan-Pacific Sci. Conference held under auspices of Pan-Pacific Union, Special Publ. No. 7, pt. 3, table opposite p. 820, Bishop Museum, Honolulu, Hawaii, 1922.

³⁶ Van Beneden, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, p. 70, 1865.

³⁷ Trouessart, E. L., Cat. Mamm. viv. foss., Berlin, fasc. 5, p. 1012, 1898.

³⁸ Molin, R., Sitzungsber. math.-naturw. Cl. Kais. Akad. der Wissenschaften, Wien, vol. 35, p. 126.

³⁹ Zigno, A. de., Mém. del Istituto Veneto di Sci., Lett. ed Arti, Venezia, vol. 20 [extract separately paged, 7], 1876.

⁴⁰ Longhi, P., Atti Soc. Veneto-Trentina Sci. Nat. resid. in Padova, ser. 2, vol. 3, fasc. 1, p. 77, 1897.

⁴¹ Brandt, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, No. 1, pp. 330, 332, 1873.

⁴² Cope, E. D., American Naturalist, vol. 24, No. 283, p. 603, July, 1890.

to include certain species of squalodonts having "some of the posterior superior molars three-rooted." No type species was designated and while some may hold that it was Cope's intention to apply this proposed name to *Squalodon gervaisii* in accordance with a key drawn up by him in 1867⁴³ he did not actually do so. The inference drawn from his remarks is that he was aware of more than one form having three-rooted upper molars. In view of the above facts it seems advisable to select a form which not only possesses such features as will fall within the limits of his diagnosis but also one that will best illustrate these peculiarities. Since *Pachyodon catulli* of Molin best fulfills these requirements it is here selected as the type of *Trirhizodon* Cope and may stand as *Trirhizodon catulli* (Molin).

MICROZEUGLONDON CAUCASICUM (Lydekker).

Zeuglodon caucasicum LYDEKKER, R., Proc. Zool. Soc. London, pt. 4, No. 38, pp. 559-561, pl. 36, figs. 1-3, April 1, 1893.

Type specimen.—Based upon the posterior portion of a left mandibular ramus containing four serrate molars, a second fragment of a jaw with five broken teeth, a left humerus, and an imperfect caudal vertebra. Loaned to Lydekker by H. Sjögren, of Upsala, Sweden.

Type locality.—"A Tertiary deposit, in company with a number of fish remains, in the Caucasus." This deposit is referable to the "Sumgait-serien" or Eocene according to Hjalmar Sjögren.⁴⁴ Both Lydekker⁴⁵ and Abel⁴⁶ have questioned this correlation, the former suggesting a Miocene age, and the latter an Upper Oligocene age for the cetacean remains.

Subsequent allocation.—Stromer⁴⁷ was the first to point out the radical differences which exist between *Zeuglodon caucasicus*, so far as represented by skeletal remains, and true *Zeuglodon*. As a result of his comparisons he concluded that these remains were not referable to any previously described genus and proposed *Microzeuglodon*. Abel⁴⁸ was so impressed by these differences that he erected a new family, Microzeuglodontidae, to include this form. At the same time he⁴⁹ remarked that there was considerable resemblance between *Zeuglodon caucasicus* Lydekker and the squalodonts *Neosqualodon assenxae* Dal Piaz and *Microsqualodon gastaldi* (Brandt). Abel remarks that so little is known concerning *Zeuglodon caucasicus* that its relationships with *Neosqualodon* can not be settled, and yet he considers there is sufficient data available for the erection of a new family for it. Both

⁴³ Cope, E. D., Proc. Acad. Nat. Sci. Philadelphia [vol. 19], p. 151, 1867.

⁴⁴ Sjögren, H., Meddelanden från Upsala Universitets Mineralogisk-Geologiska Institution, Stockholm vol. 13, fasc. 2-3, p. 4, 1891.

⁴⁵ Lydekker, R., Proc. Zool. Soc. London, pt. 4, No. 38, p. 559, 1893.

⁴⁶ Abel, O., Denkschr. Kais. Akad. Wiss. math.-naturw. Kl. Wien, vol. 90, p. 203, 1913.

⁴⁷ Stromer, E. von, Beiträge z. Paläont. u. Geol. Oester.-Ungarns u. d. Orients, Wien, vol. 15, p. 89 1903.

⁴⁸ Abel, O., Denkschr. Kais. Akad. Wiss. math.-naturw. Kl. Wien, vol. 90, p. 220, 1914.

⁴⁹ Abel, O., Idem, p. 207.

Neosqualodon and *Microzeuglodon* possess the same peculiar type of dentition and, in want of additional material, may be placed tentatively in the same limited group.

DELPHINODON? DEBILIS (Leidy).

Phoca debilis LEIDY, J., Proc. Acad. Nat. Sci. Philadelphia, vol. 8, p. 265, 1856; Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, p. 415, pl. 28, figs. 12, 13, 1869.

Type specimen.—Original description was based on three molar teeth, but one was withdrawn in 1869 and made the type of *Phoca modesta*. Types, Nos. 10324–10325, are in the Academy of Natural Sciences of Philadelphia.

Type locality.—Sands of Ashley River, South Carolina. Edisto marl or Upper Miocene.

Subsequent allocation.—This species was placed in the genus *Squalodon* by Cope.⁵⁰ The teeth as figured by Leidy do not bear any resemblance to the teeth of squalodonts, and they do not agree sufficiently with those of *Delphinodon* to be definitely referred to that genus. Even with allowance for variation, it seems probable to the writer that they represent some Miocene delphinid, as they are not suggestive of any known squalodont.

PATRIOCETUS DENGGI Abel.

Cetotheriopsis linziana BRANDT, J. F., Mem. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, No. 1, pp. 42, 43–44, pl. 18, figs. 5b, 5c, 5d, 6b, 6c, 6d, 9b, 10c, 11d (lumbar vertebrae); pl. 18, figs. 5e, 5f, 5g, 6e, 6f, 6g (caudal vertebrae), 1873. *Patriocetus denggi* ABEL, O., Denkschr. Kais. Akad. Wiss. math.-naturw. Kl. Wien, vol. 90, pp. 160, 194–199, text fig. 13, 1913.

Type specimen.—Based upon three lumbar and three caudal vertebrae. Types in the Museum Francisco-Carolinum at Linz, Austria.

Type locality.—Marine sand in the vicinity of Linz, in the valley of the Danube River, upper Austria. Upper Aquitanian or Upper Oligocene.

Subsequent allocation.—Although Abel tentatively proposes a new specific name for these vertebrae, he remarks that they may belong possibly to *Patriocetus ehrlichii* [= *Patriocetus grateloupii*]. In view of the number of types of cetacean skulls that are known from these marine sands, any allocation of isolated vertebrae will be subject to dispute.

SQUALODON EHRLICHII Van Beneden.

Squalodon ehrlichii VAN BENEDEN, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, pp. 50, 72, pl. 2, figs. 1–3, 1865.—BRANDT, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, No. 1, pp. 323–326, pl. 31, figs. 1, 1a, 1b, 2, 1873.

Type specimen.—In his original description Van Beneden associated two distinct cetaceans under this name. His material included a

⁵⁰ Cope, E. D., Proc. Acad. Nat. Sci. Philadelphia [vol. 19], p. 144, 1867.

skull with two squamosals, frontal, maxillae, premaxillae, ethmoid, and vomer; two molars in situ, and four double-rooted alveolae. Van Beneden, in addition to this skull, mentioned one premolar and two caniniform teeth. Besides the above material Van Beneden associated the skull of a supposed young individual⁵¹ with this species. Types in the Museum Francisco-Carolinum at Linz, Austria.

Type locality.—Found in a bed of marine sand in the vicinity of Linz, in the valley of the Danube River, upper Austria. Upper Aquitanian or Upper Oligocene..

Subsequent allocation.—The skull of the young individual was removed from this species by Brandt⁵² and a new species, *Squalodon incertus* [= *Agriocetus incertus* = *Agriocetus austriacus* Abel] erected for it. The other skull is the supposed saurian of Klipstein and the same one that Von Meyer named *Squalodon grateloupii*. *Squalodon ehrlichii* of Van Beneden thus becomes a synonym of *Patriocetus grateloupii* (Meyer).

NEOSQUALODON GASTALDII (Brandt.)

Squalodon gastaldii ? BRANDT, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, No. 1, pp. 326-328, pl. 32, figs. 1-23, 1873.

Type specimen.—Consists of posterior portions of two mandibles, four serrate and two caniniform teeth, a cervical, a dorsal, three lumbar, and two caudal vertebrae, and a rib. Type in the collection of the University of Turin, Italy.

Type locality.—The "molasse" of Acquia, Piemonte, Italy. The nature of the deposit may have been given erroneously by Brandt, for Portis⁵³ states that the specimens came from a limestone formation near Acquia. Abel⁵⁴ considers that this formation belongs to the Middle Miocene. Aquitaniano or Upper Oligocene.

Subsequent allocation.—A new genus, *Microsqualodon*, was proposed for this species by Abel,⁵⁵ but he withdrew the name⁵⁶ on receiving additional information from Dal Piaz. Capellini⁵⁷ has reported on the discovery of additional remains of this interesting squalodont. His material includes a tympanic and a periotic.

TRIRHIZODON GERVAISI (Van Beneden.)

Squalodon gervaisii VAN BENEDEN, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, p. 71, 1865.

Type specimen.—Name proposed for a single molar tooth figured by Gervais.⁵⁸ [An additional fragmentary molar crown is figured on

⁵¹ Van Beneden, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, pl. 2, fig. 4; pl. 3, fig. 1.

⁵² Brandt, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 21, No. 6, pp. 39 (footnote), 42, 1874.

⁵³ Portis, A., Mémoire della Reale Accad. Sci. di Torino, ser. 2, vol. 37, pp. 329-333, 1886.

⁵⁴ Abel, O., Mém. Mus. Roy. Hist. Nat. Belgique, Bruxelles, vol. 3, p. 35, 1905.

⁵⁵ Idem., p. 35.

⁵⁶ Idem., p. 36.

⁵⁷ Capellini, G., Mém. Accad. Sci. dell'Ist. di Bologna, ser. 4, vol. 2, pp. 1-9, pl. -, figs. 1-7, 1881.

⁵⁸ Gervais, P., Zool. et Paléont. franç., Paris, ed. 1, vol. 1, p. 152, pl. 8, figs. 11, 11a, 1848-1852.

pl. 8, figs. 12, 12a, and this was first described by Gervais⁵⁹ in 1846.] Type in the collection of the "Faculte des sciences de Montpellier," France.

Type locality.—From the "molasse marine" of Saint-Jean-de-Védas, a locality west of Montpellier, Department of Herault, France. Helvetian or Middle Miocene.

Subsequent allocation.—Gervais states that this molar is three-rooted. His illustration shows that the crown of the tooth is imperfect and that the terminal portions of the roots are lost. The most characteristic feature of *Trirhizodon catulli* is the anterior cutting edge of the molariform teeth, and that portion of the tooth figured by Gervais is missing. Otherwise the specimen agrees well with Molin's form, taking into consideration the amount of variation to be expected among members of this group, the similarity of the steplike arrangement of the cusps on the posterior cutting edge, and the fact that the molar is of the three-rooted type.

SAUROCETUS GIBBESII Agassiz.

Sauro-cetus gibbesii AGASSIZ, L., Proc. Acad. Nat. Sci. Philadelphia, vol. 4, pp. 4-5, 1848.

Type specimen.—Based upon one imperfect tooth which "will easily be distinguished from the fang of *Dorudon*, by its great flatness and acute serrated edge." Type in the Museum of Comparative Zoology at Harvard College, Cambridge, Massachusetts.

Type locality.—Presumably from the Ashley River phosphate deposits of South Carolina.

Subsequent allocation.—There is a possibility that future discoveries may show the tooth upon which *Saurocetus* was based to be the same as *Colophonodon holmesii*. In that event this name of Agassiz would have priority over that proposed by Leidy.

SQUALODON GRATELOUPII AUTHORS (Not Von Meyer, 1843).

See *Delphinoides gratelupi* Pedroni [= *Squalodon typicus*, new species].

PATRIOCETUS GRATELOUPII (Meyer).

Squalodon grateloupîi MEYER, H. von, Neues Jahrbuch für Mineralogie, Stuttgart, p. 704, 1843 [based upon "Sauriers (?)" of Klipstein⁶⁰].—EHRlich, C., Berichte Mittheil, Freund. naturwiss. in Wien, vol. 4, No. 2, pp. 197-199, and 4 text figs. on p. 199, 1848; Ueber die nordöstlichen Alpen, Bericht über das Museum Francisco-Carolinum, Linz, pp. 12-13, figs. a, b, c, 1850.

Squalodon ehrlichii VAN BENEDEN, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, pp. 50, 72, pl. 2, figs. 1-3, 1865.—BRANDT, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, No. 1, pp. 323-326, pl. 31, figs. 1, 1a, 1b, 2, 1873.

⁵⁹ Gervais, P., Ann. des Sci. Nat., Paris, ser. 3, vol. 5, p. 263, 1846.

⁶⁰ Klipstein, A. von, Archiv für Mineral. Geognosie, Bergbau und Hüttenkunde, Berlin, vol. 16, pt. 2, pp. 664-665, 1842.

Type specimen.—Consists of a somewhat damaged skull which possesses five cheek teeth in place, all two-rooted, but only two of which have their serrate crowns preserved. Type in the Museum Francisco-Carolinum at Linz, Austria.

Type locality.—Found in a deposit of marine sand in the vicinity of Linz, in the valley of the Danube River, upper Austria. These sands are now considered to be referable to the Upper Oligocene by Abel.⁶¹ Upper Aquitanian or Upper Oligocene.

Subsequent allocation.—The genus *Squalodon* was established by Grateloup in 1840 for part of a left upper jaw with four serrate cheek teeth which he had obtained from the "grès marin" deposits of Léognan, Department of Gironde, France. This generic name was published without mention, by name of any species. A specific name *grateloupii* was first instituted in the genus *Squalodon* by Von Meyer in 1843.

Contrary to previously published statements, Meyer⁶² did not base his *Squalodon grateloupii* upon the fragment of the jaw described as *Squalodon* by Grateloup.⁶³ He explicitly says that he proposes the name, *Squalodon grateloupii* for a cranial fragment from the Tertiary sands in the vicinity of Linz which Klipstein⁶⁴ had described as the skull of a "Sauriers (?)," and Von Meyer further remarks that this specimen will be described shortly by Fitzinger. It was not, however, until 1848 that Carl Ehrlich,⁶⁵ instead of Fitzinger, figured the supposed saurian skull of Klipstein. The type is still extant at Linz, Austria.

As this was the first specific name to be applied in this genus it has been accepted as the type. However, as shown below, this skull from Linz does not belong to the same group of cetaceans as have hitherto been grouped under the name of *Squalodon*. Authors subsequent to Von Meyer, apparently, either ignored the original application of the specific term *grateloupii* or considered that the skull found near Linz and the rostral fragment from Léognan were identical. It appears that the first unquestionable application of the term *Squalodon grateloupii* to the Léognan specimen was that of Gervais.⁶⁶ The name was also used by the same writer for a serrate cheek-tooth⁶⁷ found near Saint-Jean-de-Védas, France.

To further complicate matters, this skull of Klipstein's formed in part the basis for *Squalodon ehrlichii* of Van Beneden. The latter,

⁶¹ Abel, O., Die Stamme der Wirbeltiere, Berlin und Leipzig, p. 757, expl. for fig. 566, 1919.

⁶² Meyer, H. von, Neues Jahrbuch für Mineralogie, Stuttgart, p. 704, 1843.

⁶³ Grateloup, J. P. S., Actes Soc. Linn. de Bordeaux, vol. 11 for 1839, No. 56, p. 346, 1840; Actes Acad. Sci. Belles-lettres et Arts de Bordeaux, p. 201, 1840.

⁶⁴ Klipstein, A. von, Archiv für Mineral. Geognosie, Bergbau und Hüttenkunde, vol. 16, pt. 2, pp. 664-665, 1842.

⁶⁵ Ehrlich, C., Berichte über die Mittheil. von Freunden d. naturwiss. Wien, von Wilhelm Haidinger, vol. 4, No. 2, pp. 197-199, 4 text figs. on p. 199, 1848; Ueber die Nordöstlichen Alpen, Bericht über das Museum Francisco-Carolinum in Linz, vol. 11, p. 12, figs. a, b, c, on p. 13, 1853.

⁶⁶ Gervais, P., Zool. et Paléont. franç., Paris, ed. 1, vol. 1, p. 151, pl. 3, fig. 12, 1848-52.

⁶⁷ Gervais, P., Ann. Sci. Nat., Paris, ser. 3, vol. 5, p. 263, 1846.

in his description of the supposed new species, *ehrichii*, associated two distinct cetaceans under this name. Van Beneden's material included a skull with two squamosals, frontal, maxillae and premaxillae, ethmoid, and vomer; five cheek teeth are in place, all two-rooted, but only two have perfect crowns. This skull is the one that was mentioned by Klipstein. In addition to this skull, Van Beneden made reference to one premolar and two caniniform teeth and associated the skull of the supposed young squalodont⁶⁸ with this species. The skull of the young squalodont was removed from *Squalodon ehrlichii* by Brandt⁶⁹ and a new species, *Squalodon incertus* [= *Agriocetus incertus* = *Agriocetus austriacus* Abel], was erected for it.

In 1912, Abel⁷⁰ proposed a new genus *Patriocetus*, partly for the skull mentioned by Klipstein and partly for a well-preserved skull⁷¹ found subsequently. Abel considered that the skull represented a precursor of the true whalebone whales and proposed to place it in a new family, the Patriocetidae. Winge⁷² thought that perhaps *Patriocetus* might belong to the family Balaenidae, but it was not sufficiently represented by skeletal material to be definitely allocated.

Thus a specific name for Grateloup's *Squalodon* from Leognan, France, was never proposed by Von Meyer and he simply erred in his allocation of the Linz specimen to the genus *Squalodon*. Van Beneden⁷³ in revising the group applied the name *grateloupii* to Grateloup's specimen and redescribed Von Meyer's *Squalodon grateloupii* under the name of *Squalodon ehrlichii*. This action does not restrict the name *grateloupii* to Grateloup's specimen, for, as remarked above, Ehrlich had more than 15 years previously described and figured under the name *Squalodon grateloupii* the skull discussed by Klipstein and Von Meyer. In view of the above facts it is necessary to select another name for Grateloup's specimen which previously has been known as *Squalodon grateloupii*. For further discussion see remarks under *Delphinoides gratelupi* Pedroni.

DELPHINOIDES GRATELUPI Pedroni.

Delphinoides gratelupi PEDRONI, P. M., jr., Actes Soc. Linn. de Bordeaux, vol. 14, pp. 105-107 [pl. 1, figs. 2 and 3 do not accompany text in bound volume], 1845 [based upon *Squalodon* of Grateloup⁷⁴].

⁶⁸ Van Beneden, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 3., pl. 2, fig. 4, 1865.

⁶⁹ Brandt, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 21, No. 6, pp. 39 (footnote), 42, 1874.

⁷⁰ Abel, O., Sitzungsber. math.-naturw. Kl. Kais. Akad. d. Wissenschaften, Wien, vol. 121, pt. 1, p. 69, 1912; Denkschr. d. Kais. Akad. Wissensch. math.-naturw. Kl., Wien, vol. 90, pp. 160, 194-199, text fig. 13, pls. 1, 2, 3; figs. 1-2, 4, pl. 1, 1913.

⁷¹ König, A., Jahresb. Mus. Franc.-Carol., Linz, vol. 69, pp. 109-121, pl. 1, 1911; Stromer, E., Neues Jahrbuch für Mineralogie, Stuttgart, pp. 136-137, 1915.

⁷² Winge, H., Vidensk. Medd. fra Dansk. naturh. Foren., vol. 70, 1918. Miller, G.S., Smithsonian Misc. Coll., Washington, D. C., vol. 72, No. 8, Publ. 2650, pp. 70, 71-72, 1921 (translation).

⁷³ Van Beneden, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, pp. 68-70, 1865.

⁷⁴ Grateloup, J. P. S., Actes Acad. Sci. Belles-lettres et Arts de Bordeaux, p. 201, 1840; see also Neues Jahrbuch für Mineralogie, Stuttgart pp. 830-832, 1841.

Squalodon grateloupii Gervais, P., Zool. et Paléont. franç., Paris, ed. 1, vol. 1, p. 151, pl. 41, fig. 5 [reversed], 1848-1852.—VAN BENEDEN, P. J., and Gervais, P., Ostéographie des Cétacés vivants et fossiles, Paris, p. 430, Atlas, pl. 28, fig. 1, 1880.

Type specimen.—Based upon a basal section of the left side of the rostrum which possesses four serrate molars. Type was formerly in the private collection of Grateloup in Bordeaux, France.

Type locality.—Found at a depth of 13 or 14 meters in the quarry of Leognan, near Bordeaux, Department of Gironde, France. Mayencian⁷⁵ or Lowermost Middle Miocene.

Subsequent allocation.—Pedroni did not approve of the derivation of the name *Squalodon*, and proposed to replace it by *Delphinoides*. He redescribes Grateloup's specimen and applies the specific name *gratelupi* to it. The specific name *gratelupi* was instituted as a compliment to Grateloup and as such it should follow the same spelling as the name of the person in whose honor it was proposed. Hence *gratelupi* is an obvious misspelling or typographical error and is pre-occupied by *Squalodon grateloupii* of Von Meyer.

The present uncertainty regarding the identity of the various imperfectly known squalodonts from the Miocene of France and elsewhere is largely the result of the description of new forms on specimens which do not permit comparison. A summary of what has been published concerning some of these specimens follows.

In addition to Grateloup's squalodont, Pedroni discussed two mandibles which he considered referable to *Delphinoides gratelupi*. Gervais⁷⁶ referred the right mandible,⁷⁷ from the sandstone of Leognan, to *Champsodelphis macrogenius*. This allocation has been questioned,⁷⁸ for *Delphinus macrogenius*, as applied by Laurillard,⁷⁹ was based upon a distal fragment of the combined lower jaws. It consists of a section about 3 inches in length from the symphysial region of the rami and possesses three teeth. The type specimen apparently represents a Miocene river dolphin. It appears that Laurillard was not the first to propose *Delphinus macrogenius*, as Von Meyer⁸⁰ used this name in the same connection five years previously. The general outlines and proportions of the mandible from Leognan recalls certain squalodonts, especially *Squalodon zitteli* and *Squalodon calvertensis*. The length of the symphysis, the proportions of the ramus, especially the width, and the large size of the anterior alveolae are features common to all three.

⁷⁵ Deperet, C., Archiv Mus. d'Hist. Nat. de Lyon, vol. 4, p. 279, 1887.

⁷⁶ Gervais, P., Zool. et Paléont. franç., Paris, ed. 1, vol. 1, p. 152, pl. 41, figs. 7, 7a [reversed], 1848-1852.

⁷⁷ Pedroni, P. M., jr., Actes. Soc. Linn. Bordeaux, vol. 14, pp. 109-110, 1845.

⁷⁸ Fischer, P., Actes Soc. Linn. de Bordeaux, vol. 27, livr. 1, p. 15, 1869.

⁷⁹ Laurillard, Dict. Univ. His. Nat., vol. 4, p. 634, 1846 [based upon "dauphin a longue symphyse"]; Cuvier, G., Recherches sur les Ossements Fossiles, Paris, ed. 4, vol. 8, pt. 2, p. 160; Atlas, vol. 2, pl. 224, figs. 9, 10, 11, 1836.

⁸⁰ Meyer, H. von, Neues Jahrbuch für Mineralogie, Stuttgart, p. 327, 1841.

The other mandible mentioned by Pedroni⁸¹ is less complete and belongs to the left side. An account of this specimen can be found under *Squalodon bordae*. The outlines of this mandible are quite unlike any squalodont thus far described, though at least one writer has recently held that it represents a valid species.

There is a third mandible⁸² which should be mentioned in this connection. It was formerly in the private collection of Delfortrie and was obtained at Leognan, France. The angle and the condyle are well preserved. The coronoid is damaged on the posterior margin, and two serrate teeth are present in the ramus. No question has ever been raised regarding the relegation of this mandible to the squalodonts. It can hardly belong to the same specific form as either of the above mentioned mandibles from Leognan. The thinness of the horizontal ramus, the restriction of the symphysis to the inferior portion of the ramus, and the general appearance of the mandible as a whole suggest a distinct species.

A fourth specimen found in the "grès marin" at Leognan, France, and consisting of a nearly complete left mandible that possesses five serrate molar teeth was referred to *Squalodon grateloupi*⁸³ by Delfortrie. The illustration accompanying Delfortrie's article shows that the anterior edges of the second, third, and fourth two-rooted molariform teeth are provided with sawlike cutting surfaces and that the fifth and sixth are serrated by accessory cusps on both anterior and posterior edges. An alveolus for a seventh two-rooted tooth is present and is separated by an interval of 8 mm. from the alveolus for the sixth tooth. The mandible, as preserved, is 750 mm. in length and conforms in general proportions to that of *Squalodon calvertensis*. The horizontal ramus is deeper than that of the Maryland Squalodont. Delfortrie remarks that this mandible appears to have belonged to a *Squalodon* of larger size than those previously discovered at Leognan.

As the situation now stands the rostral fragment described by Grateloup remains without a valid name unless it can be shown that *Squalodon bordae* represents the same species. In view of the absence of an associated jaw and skull from the sandstone formation at Leognan, France, and the fact that at least two and possibly three types of squalodont mandibles are known from the Leognan deposits, it is advisable to propose the name, *Squalodon typicus*, new species, for the rostral fragment described by Grateloup as *Squalodon*. The allocation of the mandibles will best await future discoveries.

⁸¹ Pedroni, P. M., jr., Actes Soc. Linn. Bordeaux, vol. 14, pp. 107-109, 1845; Gervais, P., Zool. et Paléont. franç. Paris, ed. 1, vol. 1, p. 153, pl. 41, fig. 8 [reversed] 1848-1852.

⁸² Fischer, P., Actes Soc. Linn. de Bordeaux, vol. 27, livr. 1, pp. 12-16, pl. 2, figs. 3a, 3b, 3c, 3d, 1869; Van Beneden, P. J., and Gervais, P., Ostéographie des Cétacés vivants et fossiles, Paris, p. 446, pl. 28, figs. 4, 4a, 1880.

⁸³ Delfortrie, E., Actes Soc. Linn. de Bordeaux, vol. 27, livr. 2, pp. 133-136, pl. 5, 1869.

METASQUALODON HARWOODI (Sanger).

Zeuglodon harwoodi SANGER E. B., Proc. Linn. Soc. New South Wales, Sydney, vol. 5, pt. 3, pp. 298-300, text figs., 1881.

Type specimen.—Based upon one molar and the fragments of a second.

Type locality.—Found in a bed of yellow calcareous clay near Wellington on the Murray River in South Australia. Sanger considered that these beds were Eocene in character. More recently, Hall⁸⁴ states that the formation which comprises the Murray River cliffs is generally regarded as Janjukian. The term Janjukian has also been applied to the Santa Cruz beds of Patagonia. Various writers have placed the age of these beds from Eocene to Miocene. Lower Miocene.

Subsequent allocation.—A new genus, *Metasqualodon*, was proposed for this species by Hall.⁸⁵ According to Abel⁸⁶ the *Zeuglodon harwoodi* of Sanger should be placed in the family Microzeuglodontidae and he tentatively cited the form as *Microzeuglodon?* *harwoodi*. At present this genus is too slightly known to offer any support for judgment of its relationships.

It still remains to be shown that Hall was right in allocating the tooth from Mount Gambier with Sanger's form. The ornamentation of the enamel crown suggests a closer relationship with *Parasqualodon wilkinsoni*. In that case this tooth represents one of the posterior premolars.

COLOPHONODON HOLMESI Leidy.

Colophonodon holmesii LEIDY, J., Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 377, 1853.

Type specimen.—Represented by a nearly entire tooth, with fragments of five others. Type teeth possibly in the Academy of Natural Sciences at Philadelphia.

Type locality.—Sands of Ashley River, South Carolina. ? Edisto marl or Upper Miocene.

Subsequent allocation.—This species was referred to the genus *Squalodon* by Cope.⁸⁷ According to Leidy⁸⁸ these teeth are too small to be referred to either *Squalodon atlanticus* or *Squalodon antverpiensis*, and he suggests they may possibly bear a closer relationship with *Agorophius pygmaeus*. The remains are altogether too incomplete to propose any definite allocation in the light of our present knowledge of the fauna of these phosphate deposits.

⁸⁴ Hall, T. S., Proc. Roy. Soc. Victoria (new ser.), Melbourne, vol. 23, pt. 2, art. 23, p. 263, 1911.

⁸⁵ Hall, T. S., Idem., p. 262, 1911.

⁸⁶ Abel, O., Denkschr. Kais. Akad. Wiss. math.-naturw. Kl. Wien, vol. 90, p. 220, 1913.

⁸⁷ Cope, E. D., Proc. Acad. Nat. Sci. Philadelphia [vol. 19], p. 153, 1867.

⁸⁸ Leidy, J., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, pp. 418-420, pl. 28, figs. 15-17, 1869.

SQUALODON HYPSPONDYLUS Brandt.

Squalodon hypspondylus ? BRANDT, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 21, No. 6, p. 42, pl. 5, figs. 9-12, 1874.

Type specimen.—Species proposed provisionally for a caudal vertebra in the Museum Francisco-Carolinum at Linz, Austria.

Type locality.—No locality is given by Brandt. It is possible that the vertebra was collected by Ehrlich, and in that case it was probably found in the marine sand in the vicinity of Linz, in the valley of the Danube River, upper Austria. ? Upper Oligocene.

Subsequent allocation.—Additional material will be necessary before this species can be properly compared with other known forms.

AGRIOCETUS INCERTUS (Brandt).

Squalodon grateloupi MEYER, H. von, Neues Jahrbuch für Mineralogie, Stuttgart, p. 189, 1847 (part).

Squalodon ehrlichii BRANDT, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, No. 1, p. 360, pl. 31, fig. 3, 1873.

Squalodon incertus ? BRANDT, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 21, No. 6, pp. 39 (footnote), 42,, pl. 5, figs. 1-8, 1874.

Agriocetus austriacus ABEL, O., Denkschr. Kais. Akad. Wiss. math.-naturw. Kl. Wien, vol. 90, pp. 188-194, pl. 4, fig. 2; pl. 5, figs. 1-2; pl. 7, 1913.

Type specimen.—Based on a posterior cranial fragment of a cetacean skull that was referred to *Squalodon ehrlichii* by Van Beneden.⁸⁹ A tympanic and a lumbar vertebra are also provisionally assigned to this new species. Type in the Museum Francisco-Carolinum at Linz, Austria.

Type locality.—Found in a bed of marine sand in the vicinity of Linz, in the valley of the Danube River, upper Austria. Upper Aquitanian or Upper Oligocene.

Subsequent allocation.—Abel⁹⁰ restricted the application of the name *incertus* to the tympanic and the lumbar vertebra and proposed the new genus and species, *Agriocetus austriacus*, for the skull. Brandt, however, based his name *Squalodon incertus* upon the cranial fragment described and figured by Van Beneden and only provisionally assigned the other skeletal material to the same species. Hence, the application of *incertus* could hardly be shifted from the type skull to other included material. According to the accepted rules of nomenclature the validity of the older name *incertus* was not impaired by this process of redefinition and should stand. *Agriocetus austriacus* Abel thus becomes a synonym of *Agriocetus incertus* (Brandt). Abel regards *Agriocetus* as a near relative of *Patriocetus*, and as an intermediate stage in the evolution of the true whalebone whales.

The characters which were assumed to be peculiar to the tympanic and the lumbar vertebra are not sufficiently diagnostic to show what

⁸⁹ Van Beneden, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, pp. 72, 81, pl. 2, fig. 4, 1865.

⁹⁰ Abel, O., Denkschr. Kais. Akad. Wiss. math.-naturw. Kl. Wien, vol. 90, p. 189, 1913.

relationship they may have to the other described forms. It is doubtful whether these specimens can be identified until more complete remains are found.

SQUALODON LINZIANUS Brandt.

Squalodon linzianus BRANDT, J. F., Bull. Acad. Imp. Sci. de St.-Petersbourg, vol. 16, p. 566, October, 1871; Bull. Acad. Imp. Sci. de St.-Petersbourg, Mélanges Biol., vol. 8, p. 196, 1871; Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, No. 1, p. 47, 1873.

Type specimen.—Based upon a tympanic. Type in the Museum Francisco-Carolinum at Linz, Austria.

Type locality.—Marine sand in the vicinity of Linz, in the valley of the Danube River, upper Austria. Upper Aquitanian or Upper Oligocene.

Subsequent allocation.—Brandt's explanations are not always easily understood, for under his discussion of *Cetotheriopsis* he states that this tympanic may perhaps belong to *Squalodon linzianus*,⁹¹ though further on he clearly states that it is referable to *Squalodon ehrlichii*.⁹² Abel⁹³ refers this tympanic to his *Patriocetus ehrlichii* [= *Patriocetus grateloupii* (Meyer)].

CETOTHERIOPSIS LINTIANUS (Meyer).

Balaenodon lintianus MEYER, H. VON, Neues Jahrbuch für Mineralogie, Stuttgart, p. 550, 1849.

Stenodon lentianus VAN BENEDEN, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, pp. 73-79, pl. 4, and text figs. 2, 1865.

Type specimen.—The original description was based upon a posterior cranial fragment, an atlas and another large vertebra, a tympanic and a caniniform tooth. Von Meyer thought this tooth bore some resemblance to *Balaenodon* of Owen, and hence referred all of his material to that genus. The specimens are in the Museum Francisco-Carolinum at Linz, Austria.

Type locality.—Tertiary sands in the vicinity of Linz, in the valley of the Danube River, upper Austria. Upper Aquitanian or Upper Oligocene.

Subsequent allocation.—The year following the publication of the original description of *Balaenodon lintianus*, Meyer⁹⁴ apparently reconsidered his previously published statements and concluded he could not say positively that the tympanic and the tooth belonged to the genus *Balaenodon*. He also asserted that the cranial fragment showed more similarity to *Zeuglodon* than to *Squalodon*. The genus *Stenodon* of Van Beneden, like *Balaenodon lintianus* Meyer, was based upon a composite lot of specimens belonging to one or more unrelated cetaceans. The cranial fragment together with additional skeletal material formed the basis for the *Cetotheriopsis linziana* of

⁹¹ Brandt, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, p. 46, 1873.

⁹² Brandt, J. F., Idem, p. 333.

⁹³ Abel, O., Denkschr. Kais. Akad. Wiss. math.-naturw. Kl. Wien, vol. 90, p. 160, 1913.

⁹⁴ Meyer, H. von, Neues Jahrbuch für Mineralogie, Stuttgart, p. 205, 1850.

Brandt.⁹⁵ The tympanic⁹⁶ and the tooth⁹⁷ were referred to *Squalodon ehrlichii* by the same writer. Van Beneden,⁹⁸ also, considered that the tooth belonged to some squalodont.

Herluf Winge⁹⁹ has reviewed the history of these genera, and has pointed out that *Balaenodon lintianus* is the type of *Aulocetus* Van Beneden.¹⁰⁰ However, Van Beneden referred to this material by a vernacular name "Aulocete" in 1861, and the latinized form *Auloce-tus*¹ dates from 1875. Hence the *Stenodon* of Van Beneden would thus have priority over the subsequently proposed *Cetotheriopsis linziana* Brandt, and *Aulocetus linzianum* Van Beneden. If we accept the ruling that *Stenodon* is preoccupied by *Steneodon*,² then *Cetotheriopsis* becomes the next available name. This form represents a whale-bone whale and is included here only because of Von Meyer's remarks.

CETERHINOPS LONGIFRONS Leidy.

Ceterhinops longifrons LEIDY, J., Journ. Acad. Nat. Sci. Philadelphia, vol. 8, pp. 230-232, pl. 34, fig. 7, 1877.

Type specimen.—Consists of a fragment of a skull, comprising portions of the "frontal, ethmoid, vomer, maxillaries, and intermaxillaries, all intimately coossified." Type, No. 11420, Academy of Natural Sciences of Philadelphia.

Type locality.—Ashley River phosphate beds, South Carolina. Edisto marl or Upper Miocene.

Subsequent allocation.—This cranial fragment, composed chiefly of the bones surrounding the nasal passages, resembles *Eurhinodelphis* so closely that there appears no valid reason for separating this form from the latter genus. As remarked by Leidy the mesethmoid forms a thick partition separating the nasal passages and terminating anteriorly at the commencement of the mesorostral channel. The presence of a second pair of openings leading into the brain case and originating at the posterior end of the mesethmoid channel is shown by Leidy's figure. For the present, and in absence of a more complete skull, its exact specific allocation will best await further explorations in these deposits. The characters of this fragment, so far as they go, agree well with those of other *Ceterhinops* skulls from the Ashley River phosphate deposits and to a less extent with those of *Arionius servatus*.

⁹⁵ Brandt, J. F., Mém. Acad. Imp. Sci. de St. Petersburg, ser. 7, vol. 20, No. 1, p. 40, pl. 19, figs. 1-4, 1873; vol. 21, No. 6, pp. 6-11, pl. 1, figs. 1-16, 1874.

⁹⁶ Brandt, J. F., Idem, pp. 42, 45-46, 333, pl. 31, figs. 4, 5.

⁹⁷ Brandt, J. F., Idem, pp. 38, 42, 324, 333, pl. 31, figs. 10, 10a.

⁹⁸ Van Beneden, P. J., Mém. Acad. Roy. Sci. Belgique, Bruxelles, vol. 35, pp. 76-77, text fig. 76, 1865.

⁹⁹ Winge, H., Vidensk. Medd. fra Dansk. naturh. Foren. Kjøbenhavn, pp. 17-18, 19, 1909.

¹⁰⁰ Van Beneden, P. J., Bull. Acad. Roy. Sci. Belgique, Bruxelles, ser. 2, vol. 12, p. 480, 1861.

¹ Van Beneden, P. J., Idem, vol. 40, pp. 537-539, 1875.

² Croizet, Revue Encyclopédique, vol. 59, p. 86 (footnote), July-September, 1833.

So far as known, no squalodont skull possesses a small canal, opening near the center of the concave horizontal plate of the maxilla and approximately in line with the posterior margins of the nasal passages, which connects with the infraorbital system. Such a canal is present on the right edge of the fragment and is plainly indicated in Leidy's figure. Canals in a corresponding position are to be found in crania belonging to Yale University and obtained from the same deposits.

SQUALODON MELITENIS (Blainville).

Phoca ? melitensis antiqua and *P(hoca) dubia melitensis* BLAINVILLE, H. M. D., *Ostéographie ou description iconographique*, Paris, vol. 2, livr. 7, pp. 46, 51; *Atlas*, vol. 2, pl. 10, fig. 4, 1840.³ [Based upon the description of Scilla.⁴]

Phoca ? melitensis antiqua MEYER, H. von, *Neues Jahrbuch für Mineralogie*, Stuttgart, p. 242, 1841.

Phocodon scillae AGASSIZ, L., *Valentine's Repertorium Anat. et Physiol.* Bern and St. Gallen, vol. 6, p. 236, 1841 [based upon the type specimen].

Squalodon melitensis MCCOY, F., *Geol. Mag.* London, vol. 4, No. 34, p. 145, 1867.

Squalodon melitensis (Meyer MSS) BRANDT, J. F., *Mém. Acad. Imp. Sci. de St.-Petersbourg*, ser. 7, vol. 20, No. 1, p. 330, 1873.

Type specimen.—Consists of a fragment of the mandible with three teeth in situ. Type in Cambridge University Museum, England.

Type locality.—The tufa of Malta.⁵ Burdigalian or Lower Miocene.

Subsequent allocation.—This interesting specimen has been the subject of much controversy, and at various times has been placed with the pinnipeds, squalodonts, and zeuglodonts. Müller⁶ came to the conclusion that it represented a zeuglodont, for he says: "Ueber die generische Identität des *Zeuglodon* und der Zähne bei Scilla, hegte ich Keinen Zweifel."

SQUALODON MEYERI Brandt.

Squalodon meyeri BRANDT, J. F., *Mém. Acad. Imp. Sci. de St.-Petersbourg*, ser. 7, vol. 20, No. 1, pp. 316-318, 1873; vol. 21, No. 6, pp. 29-30, 54, pl. 4, figs. 18-19 [outline drawings of molars], 1874 [based upon the following: *Arionius servatus* Meyer⁷ and "Viertes Cetaceum der Molasse" of Jäger⁸].

Type specimen.—A poorly preserved rostral fragment obtained from Professor Schübler formed the basis of Jäger's remarks. Another incomplete skull became the type of *Arionius servatus* Meyer. Brandt, apparently, made this last-mentioned specimen the type of his *Squa-*

³ Sherborn, C. D., *Ann. Mag. Nat. Hist.* London, ser. 7, vol. 2, No. 7, p. 76, July, 1898. [Gives date of publication for livr. 7.]

⁴ Scilla, A., *De Corporibus marinis lapidescentibus*, Rome, p. 47, pl. 12, fig. 1, 1747.

⁵ Scilla, A., *De Corporibus marinis lapidescentibus*, Rome, explan. for pl. 12, 1759; and Longhi, P., *Atti della Soc. Veneto-Trentina di Sci. Nat.* resid. in Padova, ser. 2, vol. 3, fasc. 1, p. 48, 1897; Fuchs, Th., *Das Alter der Tertiärschichten von Malta*, *Sitzungsber. math.-naturw. Cl. Akad. Wiss.*, Wien, vol. 70, Abt. 1, pp. 98-100, 1875 (Aquitaniens); Haug, E., *Traité de Géologie*, Pt. 2, *Les Périodes Géologiques*, Paris, p. 1647, 1908-1911 (Burdigalien).

⁶ Müller, J., *Ueber die fossilen Reste der Zeuglodonten von Nordamerika*, Berlin, p.—, 1849.

⁷ Meyer, H. von, *Neues Jahrbuch für Mineralogie*, Stuttgart, p. 315, 1841.

⁸ Jäger, G. F., *Ueber die fossilen Säugethiere welche in Württemberg aufgefunden worden sind*, Stuttgart, pt. 1, p. 7 [specimen No. 21], pl. 1, fig. 28, 1835, and pt. 2, pp. 200, 213, 1839; Jäger, G. F., *Nova Acta Acad. Caes. Leop.*, vol. 22, pt. 2, p. 780, 1850.

lodon meyeri.⁹ Type in the "Württemberg. Naturalien Sammlung" at Stuttgart, Germany.

Type locality.—Both specimens came from the "Molasse bei Baltringen," Württemberg, Germany. The "Meeresmolasse" of Baltringen is referable to the Middle Miocene or Vindobonian according to Osborn.¹⁰

Subsequent allocation.—Trouessart¹¹ placed this species in the synonymy of *Squalodon servatus*. The species should be considered as a substitute name for *Arionius servatus* Meyer, for Brandt held this genus was without foundation and that the species properly belonged in the genus *Squalodon*.

PACHYODON MIRABILIS Meyer.

Pachyodon mirabilis MEYER, H. von, Neues Jahrbuch für Mineralogie, Stuttgart, p. 414, 1838.

Type specimen.—Original description was based upon a single tooth which was thought to bear resemblance to some pinniped. Type probably in the "Württemberg. Naturalien Sammlung" at Stuttgart, Germany.

Type locality.—Type tooth came from the "Bohnerz-Ablagerungen" of Altstadt near Mösskirch in Baden, Germany.¹² Middle Miocene.

Subsequent allocation.—Von Meyer describes this tooth in such a perfunctory manner that it should be considered unidentifiable. He says that it belongs to a phocid like animal, and so far as known to the writer, never published a figure of the specimen. A few years later, Von Meyer¹³ referred two molar teeth obtained from the "Bohnerz" formation of Mösskirch or Heudorf to this form. In 1847, he published a more detailed description¹⁴ of the teeth from Mösskirch and Baltringen. From this account it appears that the molar teeth of *Pachyodon* are serrated on one edge only and three or four distinct accessory cusps are usually present. The roots of the molars are united by a thin isthmus and the crown is high in comparison with that of *Zeuglodon*. From what has been published concerning this material, it is not possible to clear up the relationship it may have to the other described squalodonts.

Brandt¹⁵ has raised the question whether Von Meyer's *Pachyodon* has priority over Grateloup's *Squalodon*. The name *Pachyodon* should not be revived in this sense until we can be certain that Von Meyer's specimen really pertains to those cetaceans we now recognize as *Squalodon* and not some other cetacean.

⁹Brandt, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, No. 1, p. vii, 1873; and vol. 21, No. 6, pp. 30, 37, 1874.

¹⁰Osborn, H. F., The Age of Mammals, New York, p. 258, 1910.

¹¹Trouessart, E. L., Cat. Mamm. viv. foss., Berlin, fasc. 5, p. 1011, 1898.

¹²Bronn, H. G., Lethaea Geognostica, Stuttgart, vol. 3, pp. 754, 755, 1856.

¹³Meyer, H. von, Neues Jahrbuch für Mineralogie, Stuttgart, pp. 459, 460, 1841.

¹⁴Meyer, H. von, Idem, p. 673, 1847.

¹⁵Brandt, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, No. 1, p. 315, 1873.

PHOCA ? MODESTA Leidy.

Phoca modesta LEIDY, J., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, p. 415, pl. 28, fig. 14, 1869.

Squalodon ? modestus HAY, O. P., Bull. No. 179, U. S. Geol. Surv., Department of the Interior, Washington, D. C., p. 589, 1902.

Type specimen.—Original description was based upon one small tooth which was thought to bear resemblance to some phocid. This tooth is also one of the three teeth which formed the basis for *Delphinodon ? debilis* (Leidy). Type, No. 10323, the Academy of Natural Sciences of Philadelphia.

Type locality.—The Ashley River phosphatic deposits of South Carolina. Edisto marl or Upper Miocene.

Subsequent allocation.—Leidy refers this tooth to the genus *Phoca*, though he qualified his allocation with the statement that "it is not improbable it may belong to a squalodont." Allen¹⁶ concurs with this assumption. It seems more likely, from what is now known concerning the various described species of *Squalodon* and other Miocene cetaceans, that this tooth belongs to some pinniped.

SQUALODON MOLASSICUS (Bronn).

Delphinus molassicus BRONN, H. G., Neues Jahrbuch für Mineralogie, Stuttgart, p. 732, 1837 [based upon "Delphin," specimen No. 21 of Jäger¹⁷]

[*Squalodon*] ? *molassicus* TROUESSART, E. L., Cat. Mamm. viv. foss., Berlin, fasc. 5, p. 1011, 1898.

Type specimen.—Based upon a posterior fragment of the rostrum with alveolae; the tip of rostrum and brain case are wanting.

Type locality.—Stone pit of Baltringen near Biberach, Württemberg, Germany. Vindobonian or Middle Miocene.

Subsequent allocation.—See remarks under *Arionius servatus*.

KEKENODON ONAMATA Hector.

Kekenodon onamata HECTOR, J., Trans. and Proc. New Zealand Institute for 1880, Wellington, vol. 13, pp. 435-436, pl. 18, 1881.

Type specimen.—Consists of fragments of the lower jaw and some 10 teeth, including 5 cheek teeth, 1 of which is three-rooted, and 2 canines, a tympanic and a periotic. Type, Cat. No. Ma. 69, the Dominion Museum at Wellington, New Zealand.

Type locality.—The specimens were obtained by McKay of the Geological Survey "from the Upper Eocene strata of the Waitaki Valley in Otago," New Zealand. The investigations of James Park¹⁸ have yielded much information which is new concerning the occurrence of *Kekenodon* in New Zealand. He pointed out that *Kekenodon* occurs in soft calcareous sandstone or shelly sands, often glauconitic,

¹⁶ Allen, J. A., Misc. Publ. No. 12., U. S. Geol. Geogr. Surv. Terr., Dept. Interior, Washington, D. C., p. 474, 1880.

¹⁷ Jäger, G. F., Ueber die fossilen Säugethiere, welche in Württemberg aufgefunden worden sind, Stuttgart, pt. 1, p. 7, pl. 1, fig. 28, 1835; and pt. 2, pp. 200, 213, 1839.

¹⁸ Park, J., Trans. and Proc. New Zealand Institute for 1904, Wellington, vol. 37 [n. s., vol. 20], pp. 511, 522, 523, 525, 529, 540 551, June, 1905.

and that these strata belong to the Oamaru system. The invertebrate fauna led Professor Park to advance the opinion that the *Kekenodon* horizon is not older than the Middle Miocene. According to this investigator, *Kekenodon* always occurs in the same horizon, and its vertical range is very limited. Furthermore, the *Kekenodon* bone bed always occurs at the base of the Waitaki or Ngapara stone and thus belongs to the Lower Hutchinsonian or Upper Ototaran stage. Dr. J. Allan Thomson¹⁹ employs the stage names Upper Wairekan or Lower Ototaran for the *Kekenodon* bone beds. Oamaru system, Oligocene or Lower Miocene.

Subsequent allocation.—This genus was referred to the Squalodontidae by Hall,²⁰ but there is some reason for doubt regarding this allocation. The remarkably strong resemblance which these teeth bear to those of *Dorudon serratus* as represented by teeth in the collection of Yale University implies a close relationship. The unusual appearance of the accessory cusps, the character of the enamel surface of the crown, and the large size of the teeth are peculiarities which place this form among the zeuglodonts. Such features are unknown for any squalodont.

According to Park,²¹ remains of *Kekenodon onamata* have been collected at the following localities: Shelly sands and soft sandstones [loose calcareous greensand = *Kekenodon* beds] exposed on the south bank of the Waitaki River, one half a mile below the junction of the Wharekuri Stream; glauconitic greensands [Marawhenua greensand] at the base of Waitaki Stone, a mile and a half east of Marawhenua; marly greensands [Upper Waihao greensand] immediately underlying the Waitaki Stone at Waihao Forks; as well as from the Kakanui greensand on the seacoast near Kakanui Township.

An interesting discovery of supposed *Zeuglodon* vertebrae on Seymour Island has recently been reported by Wiman.²² All that is known of this form are two imperfect caudal vertebrae. There is a possibility that these vertebrae belong to a form related to *Kekenodon*.

ARCHAEODELPHIS PATRIUS Allen.

Archaeodelphis patrius ALLEN, G. M., Bull. Mus. Comp. Zool. at Harvard College, Cambridge, vol. 65, No. 1, pp. 1-14, pl., figs. 1-2, text figs. 1-3, August, 1921.

Type specimen.—"A cranium, lacking the bones of the vertex, the jugals, the teeth, and all but the nasal portion of the rostrum."

¹⁹ Thomson, J. Allan, The Notocene geology of the middle Waipara and Weka Pass district, North Canterbury, New Zealand. Trans. and Proc. New Zealand Institute, Wellington, vol. 52, p. 323, 1920; Vaughan, T. W., Proc. First Pan-Pacific Sci. Conference held under auspices of Pan-Pacific Union, Special Publ. No. 7, pt. 3, pp. 722, 726, 731, table opposite p. 732, Bishop Museum, Honolulu, Hawaii, 1922.

²⁰ Hall, T. S., Proc. Roy. Soc. Victoria, Melbourne (n. s.), vol. 23, pt. 2, art. 23, p. 258, 1911.

²¹ Park, J., Trans. and Proc. New Zealand Institute for 1904, vol. 37, pp. 509, 522, 523, 525, 529.

²² Wiman, C., Wissenschaftliche Ergebnisse der Schwedischen Südpolar-Expedition 1901-1903, Stockholm, vol. 3, pp. 3-6, pl. 1, figs. 1-4, 1916.

Type, No. 15749, Museum of Comparative Zoology, Cambridge, Massachusetts.

Type locality.—Not known. The foraminifera in the surrounding matrix indicate that it was probably derived from the Jackson formation of the Upper Eocene of the southeastern United States, possibly Alabama. There is a possibility, however, that this may be the second skull found by F. S. Holmes²³ in the Ashley River region of South Carolina. Upper Eocene.

Subsequent allocation.—The long forward sloping nasal passages, the elongate flattened nasals, parietals forming part of the vertex, as well as other features, led Allen to place this form in the family Agorophiidae. Teeth, alone, are lacking to fully corroborate this allocation. So far as can be ascertained from a study of the figures and description of *Archaeodelphis patrius* and those of True²⁴ for *Agorophius pygmaeus* it appears that Allen was justified in stating that "its relationship is perhaps nearer to *Agorophius*" than to *Prosqualodon*.

SQUALODON ? PELAGIUS Leidy.

Squalodon pelagius LEIDY, J., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, p. 420, pl. 29, fig. 1, 1869.

Type specimen.—Consists of a fragment of the left maxilla with one double-rooted molar in situ. Type in the Academy of Natural Sciences at Philadelphia.

Type locality.—From Ashley River, near Charleston, South Carolina. Edisto marl or Upper Miocene.

Subsequent allocation.—The relationships of this specimen are very uncertain according to Leidy and he expressed some doubt as to whether it should be referred to a squalodont.

CYNORCA PROTERRA Cope.

Squalodon proterrus COPE, E. D., Proc. Acad. Nat. Sci. Philadelphia [vol. 19], p. 151, 1867.

Type specimen.—Consists of a single canine tooth. Type in the Academy of Natural Sciences at Philadelphia.

Type locality.—Not stated in the original description. It is given as Charles County, Maryland, by Leidy.²⁵ Calvert or Upper Miocene.

Subsequent allocation.—Cope²⁶ thought the peculiar appearance of this tooth warranted the establishment of a new genus, *Cynorca*, for it. Leidy²⁷ was of the opinion that the type tooth of this supposed squalodont belonged to some peccary, and that the two other teeth²⁸ mentioned by Cope might be the same as that described as *Squalodon*

²³ Tuomey, M., Report of the Geology of South Carolina, Columbia, p. 166, 1848.

²⁴ True, F. W., Remarks on the type of the fossil cetacean *Agorophius pygmaeus* (Müller), Publ. 1694, Smithsonian Institution, p. 7, 1907.

²⁵ Leidy, J., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, p. 385, 1869.

²⁶ Cope, E. D., Proc. Acad. Nat. Sci. Philadelphia, [vol. 19], p. 152.

²⁷ Leidy, J., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, pp. 384-385.

²⁸ Leidy, J., Idem., p. 423.

pelagius. The tooth mentioned above was clearly designated as the type by Cope, and since it was originally described as a species of the genus *Squalodon*, it invalidates any subsequent use of this specific name in this genus. There are four teeth, however, labeled with this name, from Ashley River, South Carolina, in the Academy of Natural Sciences of Philadelphia. Two of these teeth are figured by Leidy²⁹ and described under the name of *Squalodon protervus*. Whatever the determination of this last mentioned material may eventually prove to be, it is evident that the use of the specific name *protervus* in this sense is invalid.

AGOROPHIUS PYGMAEUS (Müller).

Zeuglodon pygmaeus MÜLLER, J., Ueber die fossilen Reste der Zeuglodonten von Nordamerika, Berlin, p. 29, pl. 23, figs. 1, 2, 1849.

Squalodon pygmaeus LEIDY, J., Journ. Acad. Nat. Sci. Philadelphia, ser 2, vol. 7, p. 420, pl. 29, figs. 7, 8, 1869.

Type specimen.—Consists of an imperfect skull and one serrate molar tooth. Formerly in the private collection of F. S. Holmes and now appears to have been lost.

Type locality.—Eocene marl at Greer's Landing on the Ashley River, about 10 miles from Charleston, South Carolina. These beds of soft limestone along the Ashley River are known as the Ashley-Cooper marl, and are referable to the Jackson group according to Willis.³⁰ Upper Eocene.

Subsequent allocation.—The original publication on the discovery of this specimen³¹ attracted the attention of J. Müller, who was at that time engaged in a revision of the zeuglodonts, and a description and figure of the specimen appeared in his work under the name of *Zeuglodon pygmaeus*. During the preceding year, Tuomey,³² State geologist of South Carolina, published some additional information regarding this cetacean. He remarked:

The first intimation of this strange cetacean, on the Ashley, I owe to Mr. F. S. Holmes, who sent me a portion of the upper jaw, with one perfect tooth in its proper socket; and although it differed in size and in other respects from all the specimens hitherto discovered, its *Zeuglodon* characteristics were quite evident, and, with the rest of the skull (afterwards found by Prof. L. R. Gibbes), added very materially to our knowledge of the true affinities of this cetacean. Other bones, and among them a perfect scapula and another skull, have since been found by Mr. Holmes.

In 1895, Cope³³ proposed a new generic name, *Agorophius*, for this specimen and concluded that it was generically distinct from *Squalodon* and *Dorudon*. He remarks: "The form of the skull in this genus

²⁹ Leidy, J., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, pl. 28, figs. 18 and 19.

³⁰ Willis, B., Prof. Paper No. 71, U. S. Geol. Surv., Washington, D. C., p. 739, 1912.

³¹ Tuomey, M., Proc. Acad. Nat. Sci. Philadelphia, vol. 3, pp. 151-153, 1847; Journ. Acad. Nat. Sci. Philadelphia, vol. 1, pp. 16-17, 1847.

³² Tuomey, M., Report of the geology of South Carolina, Columbia, p. 166, 1848.

³³ Cope, E. D., Proc. Amer. Philos. Soc., vol. 34, No. 147, p. 139, 1895.

approaches distinctly that of *Cetotherium* of the Balaenidae, and the permanent loss of the teeth would probably render it necessary to refer it to a *Mystacocete*." True³⁴ has reviewed the history of this interesting specimen and suggests that: "The large extension of the parietals on the superior surface of the skull in *Agorophius* indicates that it is a primitive form and it is not unlikely that some such form was the ancestor of both *S. ehrlichii* [= *Patriocetus grateloupii*] and typical *Squalodon*. That *Agorophius* itself is in the direct line is improbable on account of the form of the teeth." Abel³⁵ erects a new family *Agorophiidae* to include *Agorophius* and *Prosqualodon*, and considers this family as ancestral to the true squalodonts.

SQUALODON QUATERNARIUM Forsyth-Major.

Squalodon quaternarium FORSYTH-MAJOR, C. J., Atti della Soc. Toscana di Sci. Nat. residente in Pisa (Processi Verbali), vol. 2, p. 227, 1881.

Type.—Original brief description was based upon a single tooth that was found associated with the remains of a number of Quaternary mammals, including "*Rhinoceros hemitechus*, *Elephas antiquus*, and *Ursus spelaeus*."

Type locality.—Found in the "breccia ossifera di Montetignoso," near Livorno, Italy. Quaternary?

Subsequent allocation.—This specimen is mentioned by Portis³⁶ and he, apparently, believed the tooth presented characters that would distinguish it from previously described forms. Forsyth-Major failed to give an intelligible description for this tooth and hence the name *quaternarium* has no standing.

PHOCA ? RUGIDENS Meyer.

Phoca ? rugidens MEYER, H. von, Neues Jahrbuch für Mineralogie, Stuttgart, p. 309, 1845.

Type specimen.—"Zähne von einem *Phoca*-artigen Thier, das ich *Phoca ? rugidens* nenne."

Type locality.—Neudorf on the March River near Pressburg, Hungary. Middle Miocene.

Subsequent allocation.—In discussing this tooth, Von Meyer³⁷ states that it is smaller and possesses fewer accessory cusps than those of *Phoca* [= *Microcetus*] *ambigua* and that the cusps do not extend up the sides of the main cone. He concludes that the type tooth exhibits a closer relationship with the genus *Phoca* than with *Squalodon* or *Zeuglodon*.

This species was placed provisionally in the genus *Pristiphoca* by Trouessart.³⁸ It is possible that this tooth may belong to a pinniped

³⁴ True, F. W., Remarks on the type of the fossil cetacean *Agorophius pygmaeus* (Müller), Publ. 1694, Smithsonian Institution, p. 7, 1907.

³⁵ Abel, O., Denkschr. Kais. Akad. Wiss. math-naturw. Kl. Wien, vol. 90, p. 220, 1913.

³⁶ Portis, A., Mémoire della Reale Accad. delle Sci. di Torino, ser. 2, vol. 37, p. 333, 1886.

³⁷ Meyer, H. von, Neues Jahrbuch für Mineralogie, Stuttgart, p. 674, 1847.

³⁸ Trouessart, E. L., Cat. Mamm. viv. 'oss., Berlin, fasc. 2, p. 380, 1897.

and not to a cetacean. At present this form is too imperfectly known to be discussed, and if the type is still in existence it will need to be restudied and figured to show whether Meyer was right or not.

PHOCODON SCILLAE Agassiz.

See *Squalodon melitensis* (Blainville).

SQUALODON SERRATUS Davis.

Squalodon serratus DAVIS, J. W., Sci. Trans. Roy. Dublin Soc., ser. 2, vol. 4, pp. 46-48, pl. 7, fig. 9, 1888.—HALL, T. S., Proc. Roy. Soc. Victoria (n. s.), vol. 23, pt. 2, art. 23, p. 258, 1911.

Type specimen.—Consists of a single tooth enveloped in a matrix of light-colored calcareous sandstone. "The crown only is exposed and consists of a number of cones, of which six are visible, having obtusely pointed apices." Type in the Canterbury Museum, Christchurch, New Zealand.

Type locality.—"White Rock River Quarry," New Zealand. There is some uncertainty about this locality. According to the Geological Survey Department of New Zealand it is not White Rock River, Pareora, but probably "White Rock" Quarries, Okuku River, North Canterbury.³⁹ This squalodont should be referred to the Ototaran stage. Oamaru system; Oligocene or Lower Miocene.

Subsequent allocation.—Hall states that he "would doubtfully place this form under the synonymy of Sanger's species" *Metasqualodon harwoodi*.

ARIONIUS SERVATUS Meyer.

Arionius servatus MEYER, H. von, Neues Jahrbuch für Mineralogie, Stuttgart, pp. 315-331, 1841; Palaeontographica, Cassel, vol. 6, pp. 31-43, pl. 6, figs. 1-9, 1856-1858.

Type specimen.—Consists of an incomplete skull which was partially embedded in a large block of sandstone. The symphysial portion of the lower jaws, conical teeth, and other bones were also preserved in this slab. Type in the "Württemberg. Naturalien Sammlung" at Stuttgart, Germany.

Type locality.—Sandstone formation of Baltringen, near Biberach, Württemberg, Germany. Vindobonian or Middle Miocene.

Subsequent allocation.—Van Beneden⁴⁰ referred this form to the genus *Squalodon*. If *Delphinus molassicus* of Bronn⁴¹ belongs to the same species as the skull upon which *Arionius servatus* Meyer was based, then this last mentioned species will stand as a synonym of *Squalodon molassicus* (Bronn). This allocation is open to question, for Schübler's rostral fragment is so imperfect that actual comparison of the two specimens would be necessary to decide their relationship.

³⁹ Hector, J., New Zealand Geol. Surv. Report, vol. 22, p. 119, 1894; Morgan, P. G., New Zealand Geol. Surv., Paleont. Bull. No. 7, p. 37, 1918.

⁴⁰ Van Beneden, P. J., Ostéographie des Cétacés, Paris, pp. 438-439; Atlas, pl. 28, figs. 22-24, 1880.

⁴¹ Bronn, H. G., Neues Jahrbuch für Mineralogie, Stuttgart, p. 732, 1837.

The alveolae of this rostral fragment as figured by Jaeger⁴² are essentially the same as those found in the skulls of true squalodonts. Joseph Probst⁴³ has suggested that the teeth discussed by Van Beneden⁴⁴ under the name of *Squalodon servatum*, belong to *Squalodon catulli*. However, Probst drew his conclusions from the rostral fragment, with teeth in situ, described and figured by De Zigno⁴⁵ under the name of *Squalodon catulli*.

The anterior end of the presphenoid is exposed and forms a plug across the proximal end of the mesorostral channel in the skull of *Squalodon calvertensis*. If Lortet's figure of *Squalodon bariensis* and Von Meyer's figure of *Arionius servatus* are correct, the mesethmoid in these forms a partition separating the nasal passages externally and diminishes in thickness anteriorly, presumably sheathing the vomer for a short distance forward. At any event there is no indication of the presence a presphenoid plug at the proximal end of the mesorostral channel.

According to Probst⁴⁶ the type skull of *Arionius servatus* possesses alveolae unlike those found in the skulls of other squalodonts. In this article he compares the teeth found near Baltringen with the teeth of *Squalodon zitteli* from Bleichenbach-sur-Rott, Bavaria, but concludes they show more relationship to the Italian specimens. It still remains to be shown that there are two species of squalodonts in the sandstone formation in the vicinity of Baltringen.

PHYSOTHERIUM SOTTERII Portis.

Physotherium sotterii PORTIS, A., Mémoire della Reale Accad. delle Sci. di Torino, ser. 2, vol. 37, pp. 325-326, pl. 7, figs. 91-94, 1886.

Type specimen.—Original description based upon a fragment of a jaw, with four teeth in situ. Type probably in the collection of the University of Turin, Italy.

Type locality.—From the marine deposits "dell'Astigiana," probably in the valley of the Andona River, Italy. Astiano⁴⁷ or Upper Pliocene.

Subsequent allocation.—This species is based upon such poor material that accurate determination or comparison with the other described forms is impossible. Abel⁴⁸ states that this genus does

⁴²Jäger, G. F., Ueber die fossilen Säugethiere, welche in Württemberg aufgefunden worden sind, Stuttgart, pt. 1, pl. 1, fig. 23, 1835.

⁴³Probst, J., Jahreshefte des Vereins für vaterl. Naturkunde in Württemberg, vol. 47, pp. 49-67, pl. 1, 1885.

⁴⁴Van Beneden, P. J., Bull. Acad. Roy. Sci. des Lettres et des Beaux-Arts, Bruxelles, ser. 2, vol. 41, No. 3, p. 474, pl.—, figs. 4-5, 7-9, 1876.

⁴⁵Zigno, A. de, Mém. R. Istituto Veneto di Scienze, Lettere et Arti, Venezia, vol. 20, pp. 8-13. pl.—, figs. 1-3, 1876.

⁴⁶Probst, J. Jahreshefte des Vereins für vaterl. Naturkunde in Württemberg, vol. 47, pp. 52, 53, 1885.

⁴⁷Sacco, F., Catalogo Paleontologico del Bacino Terziario del Piemonte, Boll. della Soc. geol. Italiana, vol. 8, fase. 3, p. 191, 1890.

⁴⁸Abel, O., Mém. Mus. Roy. Hist. Nat. Belgique, Bruxelles, vol. 3, p. 53, 1905.

not belong in the *Physeteridae*, as is shown by the base of the crown and the rapid narrowing of the roots.

TRI RHIZODON SUESSII Brandt.

? *Squalodon suessii* BRANDT, J. F., Mém. Acad. Imp. Sci. de St.-Petersbourg, ser. 7, vol. 20, No. 1, p. 330, pl. 32, figs. 24a, b, c, 1873.

Squalodon catulli ZIGNO, A. de, Mém. del Istituto Veneto di Sci., Lett. et Arti, Venezia, vol. 20 [extract separately paged, 1-17], pl. —, figs. 1-5, 1876.

Type specimen.—Name proposed for a single serrate cheek tooth which is characterized by striae and by three anterior and two posterior secondary cusps. Type in the "K. K. Hofmineralienkabinet" [=Naturhistorischen Staatsmuseum] at Vienna, Austria.

Type locality.—Not known with certainty for the type specimen was labeled "S. Miniato, Toscana?," Italy. ? Lower Miocene.

Subsequent allocation.—In 1868 Suess⁴⁹ described this tooth and considered that it represented an undescribed species. At the time Brandt published his studies on the fossil cetaceans of Europe, squalodonts were very imperfectly known, and it was advisable to place on record every specimen collected. By giving this particular tooth a name, Brandt succeeded in preventing the record of the occurrence of a fossil squalodont in Tuscany from passing into obscurity. The presence of well defined and freely projecting cusps on both anterior and posterior cutting edges places this tooth among the most posterior of the molariform series. A second specimen found near Belluno, Italy, and consisting of a portion of the rostrum with 14 teeth in place was referred to *Squalodon catulli* by De Zigno. This specimen was considered to be very similar if not identical with *Squalodon bariensis* by Dal Piaz.⁵⁰ It is not clear why Dal Piaz arrived at this conclusion, unless one is to believe the figures given by De Zigno are inexact. The illustrations accompanying Dal Piaz's article leave much to be desired, and the reproduction of De Zigno's specimen is not nearly as clear as the original plate. A close study of the figures accompanying the accounts of De Zigno, Suess, and Dal Piaz indicate that these two specimens unquestionably belong to the same species. There may be some doubt whether the sixth tooth in the upper jaw has three roots as stated by De Zigno for his figures show only two-rooted molars.⁵¹ The rostral fragment does not possess a complete molar series, and some of the posterior molars may possibly have had three roots. A characteristic feature of the molars of both of these specimens is the peculiar saw-toothed appearance of the anterior cutting edges.

⁴⁹Suess, E., Jahrb. d. geol. Reichsanstalt, Wien, vol. 18, p. 290, pl. 10, figs. 4a-4c, 1868.

⁵⁰Dal Piaz, G., Palaeontographia Italica, Pisa, vol. 6, p. 310, pl. 28, fig. 1, 1901.

⁵¹De Zigno, A. de, Mém. del. Istituto Veneto di Sci., Lett. et Arti, Venezia, vol. 20, pl. —, figs. 1-3, 1876.

SQUALODON TIEDEMANI Allen.

Squalodon tiedemani ALLEN, J. A., Bull. Amer. Mus. Nat. Hist., vol. 2, art. 2, pp. 35-39, pls. 5-6, 1887.

Type specimen.—Consists of the rostral portion of the skull, 50 cm. in length, with 12 teeth in place and 2 vacant alveolae. Type, No. 10445, department of geology, American Museum of Natural History, New York.

Type locality.—Specimen was obtained "in dredging phosphatic material from the Wando River, at Charleston, this material occurring in detached fragments in the mud of the river bottom; it was thus presumably an erratic from the phosphate beds of the neighboring region," South Carolina. ? Edisto marl or Upper Miocene.

Subsequent allocation.—Allen remarks⁵² that this rostral fragment indicates a species of much larger size than *Squalodon holmesii*, "and on this account perhaps might be provisionally referred to *Squalodon atlanticus*." The crowns of the premolars of this specimen are imperfectly preserved, and the characters exhibited by the cutting edges of these teeth are thus unknown. Considerable uncertainty exists as to whether or not *Squalodon tiedemani* should be placed nearest the squalodonts or the zeuglodonts. The teeth of this form may suggest relationship with either group, but in the point of size it is much larger than any previously described squalodont. A careful comparison of the types of *Squalodon atlanticus* and *Squalodon tiedemani* has failed to convince the writer that these two cetaceans are closely related to one another.

RHYTISODON TUBERCULATUS Costa.

Rhytisodon tuberculatus COSTA, O. G., Atti dell'Accad. Pontaniana, Naples, vol. 7, pt. 1, fasc. 1, pp. 83-84, pl. 6, figs. 16a, b, 17, 18, 1853 [an earlier reference is quoted, namely, Costa, O. G., Cenni sulle scoperte paleontologiche fatte nel Regno durante l'anno 1851, Naples, pp. 10, 11, 1852].—CAPELLINI, G., Mémoires della Accad. delle Sci. dell'Istituto di Bologna, ser. 3, vol. 9, fasc. 2, pp. 242-243, pl. 2, fig. 4, 1878.

Type specimen.—Original description was based upon one rugose molar tooth, consisting of a nearly perfect crown, but with the base of only one root present, the other having been broken off below the crown. Type, No. 4527, collection of the "Museo geologico della R. Università di Napoli," Italy.

Type locality.—Type tooth came from the "calcere leccese, a mezzo miglio allo incirca dalla Città, verso l'owest, ed alla profondità di palmi 34." Environs of Lecce, Compartment of Apulia, Italy. Langhiano or Lower Miocene.

Subsequent allocation.—It was not until 1864 that Costa⁵³ understood the true relationships of this tooth and placed it near *Squalodon*.

⁵² Allen, J. A., Bull. Amer. Mus. Nat. Hist., vol. 2, art. 2, pp. 38-39, 1887.

⁵³ Costa, O. G., Atti dell'Accad. Pontaniana, Naples, vol. 8, Appendice, p. 85, 1864.

SQUALODON TYPICUS, new species.

See *Delphinoides gratelupi* Pedroni.

DIOCHOTICHUS VANBENEDENI (Moreno).

Notocetus Van Benedeni MORENO, F. P., Revista de Museo de La Plata, vol. 3, pp. 397-400, pl. 11, 1892.

Type specimen.—Consists of a skull in a fair state of preservation, mandibles, and a part of the vertebral column. Type in the "Museo de La Plata," Argentine Republic.

Type locality.—Port Madryn on Bahía Nueva, Chubut Territory, Patagonia, latitude 42° 30' south. Julian beds or Lower Miocene.

Subsequent allocation.—In February, 1894, Ameghino⁵⁴ proposed *Diocotichus* as a new generic name for *Notocetus* Moreno because he considered the later name to be preoccupied by *Notiocetus* Ameghino.⁵⁵ An additional name, *Argyrodelphis*, was inadvertently proposed for Moreno's specimen by Lydekker.⁵⁶

This form is considered to belong to the family Physteridae by Winge⁵⁷ and to represent the most primitive genus of the Xiphiini. A study of the Pescadores skull, however, convinced True⁵⁸ that *Diocotichus* belonged to the family Squalodontidae, or, in other words was a squalodont with simple teeth, having single roots and conical crowns. The posterior teeth are furnished with minute fore-and-aft cusps. It shares the following features with *Squalodon*. The orbital plates of the maxillae are shorter anteriorly than the thicker frontal plates, leaving a considerable portion of the latter exposed in front. The mesorostral channel is open proximally though nearly closed distally by the approximation of the overhanging premaxillae. The zygomatic processes are large, thick, and oblong. The premaxillae are expanded anteriorly and abbreviated posteriorly. A pair of large ophthalmic foramina are also present at the end of the mesethmoid gutter. The presence of these foramina in both *Squalodon* and *Diocotichus* does not necessarily indicate relationship, for they occur also in *Eurhinodelphis*. Furthermore, it differs from *Squalodon* in that the posterior margins of the temporal fossae overhang and project beyond the plane of the condyles.

A somewhat different view of the relationships of *Diocotichus* was advanced by Dal Piaz.⁵⁸ This writer proposed a new family, Squalodelphidae, to include the Italian *Squalodelphis* and the Patagonian *Diocotichus*.

⁵⁴ Ameghino, F., Énum. Synopt. Mamm. Foss. Éocén. Patagonie, p. 182, 1894.

⁵⁵ Ameghino, F., Revista Argentina Hist. Nat., vol. 1, entr. 3a, p. 167, 1891.

⁵⁶ Lydekker, R., Anal. Mus. La Plata, Palaeont. Argentina, vol. 2 for 1893, art. 2, pp. 12-13, April, 1894; Natural Science, vol. 4, No. 24, p. 126, February, 1894.

⁵⁷ Winge, H., Smithsonian Misc. Coll., Washington, D. C., vol. 72, No. 8, Publ. 2650, p. 38, 1921 (translation by G. S. Miller, jr.).

⁵⁸ True, F. W., Bull. Amer. Mus. Nat. Hist., vol. 28, art. 4, pp. 19-32, pls. 1-5, 1910; Dal Piaz, G., Gli Odontoceti del Miocene Bellunese. Parte Terza. Squalodelphis fabianii. Mem. Ist. geol. R. Univ. di Padova, vol. 5, pp. 1-34, pls. 1-5, 1916.

PHOCOCETUS VASCONUM (Delfortrie).

Zeuglodon vasconum DELFORTRIE, E., Actes de la Société Linneenne de Bordeaux, ser. 3, vol. 9, pp. 113-117, text figs. A, B, C, D, 1873.

Type specimen.—This supposed zeuglodont was described from a single imperfect molar tooth. The specimen was formerly in the private collection of Dr. E. Delfortrie at Bordeaux, France.

Type locality.—Bone breccia of Saint-Médard-en-Jalle, near Bordeaux, France. This deposit is referred to the Middle Miocene by Tournouer.⁵⁹ Upper Oligocene.

Subsequent allocation.—Gervais⁶⁰ proposed a new genus, *Phococetus*, for this form. Stromer⁶¹ has suggested that certain peculiarities possessed by this tooth, such as the conformation of the enamel crown and the union of the roots, are quite like those exhibited by molars of *Kekenodon onamata*. The lack of more complete material representing both *Phococetus* and *Kekenodon* hinders detailed comparisons. The marked resemblance, however, between some of the molars of *Dorudon serratus* and the published figures of *Phococetus* and *Kekenodon* is strongly suggestive of a close relationship. At any event Abel⁶² is justified in remarking that *Phococetus* is at least an offshoot of zeuglodont stock.

It should be noted that Costa⁶³ has published a figure of an imperfect tooth obtained in Italy which compares favorably with Delfortrie's specimen.

GRAPHIODON VINEARIUS Leidy.

Graphiodon vinearius LEIDY, J., Proc. Acad. Nat. Sci. Philadelphia [vol. 22], p. 122, 1870; Report U. S. Geol. Surv. Terr., Washington, D. C., vol. 1, p. 337, pl. 22, fig. 7, 1873.

Type specimen.—Original description was based on a single tooth which was thought to bear resemblance to a mosasauroid. Type, No. 875, Division of Vertebrate Palaeontology, United States National Museum.

Type locality.—"Miocene Tertiary deposit of Gay Head, Marthas Vineyard," Massachusetts. Upper Miocene.

Subsequent allocation.—It was, no doubt, in part the supposed resemblance in form of this tooth to those of the mosasauroids that induced Leidy to suggest such a determination. The peculiar shape of the tooth and the unusual type of sculpturing present on the enamel crown are unlike any known fossil or recent cetacean. It differs in like manner from the mosasaurs. As teeth with large gibbous roots are characteristic of certain members of the Physeteridae, this

⁵⁹ Tournouer, R., Actes Soc. Linn. de Bordeaux, ser. 3, vol. 9, pp. 119-161, 1873.

⁶⁰ Gervais, P., Journal de Zoologie, Paris, vol. 5, No. 1, pp. 64-70, text figs. 2, 1876.

⁶¹ Stromer, E. von, Beiträge zur Paläont. u. Geol. Oster.-Ungarns u. d. Orients, Wien, vol. 15, p. 87, 1903.

⁶² Abel, O., Denkschr. Kais. Akad. Wiss. math.-naturw. Kl. Wien, vol. 90, p. 209, 1913.

⁶³ Costa, O. G., Atti dell'Accad. Pontaniana, Napoli, vol. 8, Appendice, pl. 5, fig. 7, 1864; Capellini, G., Mémoire della Accad. delle Sci. dell'Istituto di Bologna, ser. 3, vol. 9, fasc. 2, p. 242, pl. 2, fig. 5, 1878.

form might perhaps be referred to that family. Cope⁶⁴ referred this species to the genus *Squalodon*.

SQUALODON ? VOCONTIORUM Delfortrie.

Squalodon vocontiorum DELFORTRIE, E., Actes de la Societe Linneenne de Bordeaux, ser. 3, vol. 9, pp. 257-263, pl. 7, figs. 1-5, 1874.

Type specimen.—Consists of a single well-worn molar tooth. Type was formerly in the private collection of Dr. E. Delfortrie at Bordeaux, France.

Type locality.—Taulignan, Department of Drome, France, "sur un mamelon appelé Serre de Vêlan, au pied d'une roche sableuse exploitée dans le pays sous le nom de Safre." Helvetian or Middle Miocene.

Subsequent allocation.—This species was considered to be a synonym of *Squalodon grateloupii* Authors by Deperet.⁶⁵ The molar is unlike that of any squalodont hitherto described, so far as known to the writer, and probably represents an unknown toothed whale. The molar crown is low and is not incurved toward apex. The tooth is constricted below the enamel crown. Some of these same features are to be observed in the teeth of *Patriocetus grateloupii*.⁶⁶

PARASQUALODON WILKINSONI (McCoy).

Squalodon wilkinsoni MCCOY, F., Geol. Mag., London, vol. 4, No. 34, p. 145, pl. 8, fig. 1, 1867.

Type specimen.—A single striate molar tooth characterized by the imperfect bifurcation of the root; the terminal half of one root is missing, the other is blunt with "incurved end." Type in the National Museum of Natural History, Geology, and Ethnology, at Melbourne, Australia.

Type locality.—The sandy Miocene Tertiary beds of Castle Cove, Cape Otway, coast of Victoria, Australia. Jan Jukian series or Lower Miocene.

Subsequent allocation.—A new genus, *Parasqualodon*, was proposed for this species by Hall.⁶⁷ This writer also referred additional teeth found subsequently at Waurn Ponds, Table Cape, and Spring Creek, Australia, to this species. Hall remarks that one of the molars belonging to the collection of the geological department of Adelaide University and from Table Cape, bore the manuscript name, *Zeu-glodon brevicuspidatus*, of the late Professor Tate.

⁶⁴ Cope, E. D., American Naturalist, vol. 24, p. 615, 1890.

⁶⁵ Deperet, C., Archiv. Mus. Nat. Hist., Lyon, vol. 4, p. 273, 1837.

⁶⁶ Suess, E., Jahrb. d. K. K. Geol. Reichsanstalt, Wien, vol. 13, pl. 10, figs. 2a-d, 1868; Ehrlich, C., Ueber die nordöstlichen Alpen, Bericht über das Museum Francisco-Carolinum, Linz, vol. 11, p. 13, fig. c, 1850.

⁶⁷ Hall, T. S., Proc. Roy. Soc. Victoria, new ser., vol. 23, pt. 2, art. 23, p. 262, 1911; Richards, H. C., Proc. First Pan-Pacific Sci. Conference held under auspices of Pan-Pacific Union, Special Publ. No. 7, pt. 3, p. 749, Bishop Museum, Honolulu, Hawaii, 1922; Chapman, F., Proc. Roy. Soc. Victoria, new ser., vol. 30, pt. 1, p. 41, Melbourne, 1917.

SQUALODON ZITTELI Paquier.

Squalodon zitteli PAQUIER, V., Mém. Soc. Geol. de France, Paris, Paleontologie, vol. 4, Memoire No. 12, pp.15-16, 1894 [based upon *Squalodon bariensis* Zittel, K. von (not Jourdan), Palaeontographica, Stuttgart, vol. 24, pp. 233-248, pl. 35, 1876-77].

Type specimen.—Consists of an incomplete skull and the anterior portions of the two lower jaws. The rostrum is in an excellent state of preservation with three incisors, one canine, five premolars, and three molars in place on the left side. Four additional molars were present originally as is attested by the alveolae, some of which still contain fragments of the roots.

Both lower jaws are represented by the entire symphysial region and considerably more than the anterior half of either jaw. The left mandible possesses three incisors, one canine, four premolars, four molars, and the anterior root of the fifth. The symphysial region represents more than one-third the total length of either lower jaw. The basioccipital, exoccipitals, squamosals, jugals, and a considerable portion of both postorbital processes of the frontals are missing. The bones forming the vertex and the superior wall of the cranium are sufficiently well preserved to indicate their relations to one another. The type is in the "Palaeontologische Sammlung" at Munich, Germany.

Type locality.—In the neighborhood of the village of Bleichenbach upon the Rott River, 2 kilometers from Birnbach, lower Bavaria, Germany. The specimen was obtained during the excavation of a high sand hill, and was found about 12 feet below the surface. Middle Miocene.

GENERAL DISCUSSION.

The squalodonts according to our present knowledge scarcely attained a length of 20 feet. This, however, is only an estimate based upon isolated vertebrae as very little is known concerning the skeletons of the several forms previously described.

It is premature in the light of available data to consider the validity of the various genera into which the squalodonts have been divided by previous writers; this task will await the acquisition of more complete material. Cetologists are, however, quite aware that the genus *Squalodon* is made up of forms differing greatly in appearance, and that it is much in need of revision.

The following key is based essentially upon data obtained from a careful perusal of descriptions and an extensive comparison of the figures of various authors. Necessarily the possibility for error is considerable, because in fossil cetaceans genera and species have been founded upon totally different parts of the skeleton, which do not permit comparison with one another. This renders it difficult to decide how many of the described forms really represent valid or distinct species. In the case of the shark-toothed cetaceans or

squalodonts, 20 supposed new species were based either upon isolated teeth or small fragments of bone with two or three teeth in situ. Many of the others are known only from portions of skulls, and no complete skeleton has thus far been described. It is only by careful deduction that it has been possible for the writer to incorporate many of the species in the key. It will be necessary to observe care in accepting the relationships indicated in the key since the relegation of certain species as allies to others is largely arbitrary and based upon the opinion of the writer. No apology, however, is offered for tabulating the included data as such scattered descriptions retard progress in paleontology as in other sciences more than any errors that may occur in the present key.

The writer realizes that the teeth of cetaceans are not especially adapted for the formulation of a key but the lack of detailed data concerning the skulls and skeletons of most of the described forms prevents one from utilizing such features.

KEY TO THE SHARK-TOOTHED CETACEANS, EXCLUSIVE OF THE ZEUGLODONTIDAE.

MICROZEUGLODONTIDAE.

A¹. Molars small; antero-posterior diameter of crown more than 10 mm. and less than 16 mm.

B¹. Anterior and posterior cutting edges of molariform teeth with accessory cusps or tubercles; the serrations are as fully developed on the anterior as on the posterior cutting edge. Enamel of crowns of molars lightly sculptured or ornamented with striae.

b¹. Three accessory cusps present on posterior cutting edge of posterior lower molars. Cheek teeth, apparently, considerably increased above the typical number 44; ten, and possibly more, of those in each maxilla are serrate, and two-rooted (Italy)..... *Neosqualodon assenzae*.
Neosqualodon gastaldi.

b². Four to five accessory cusps present on posterior cutting edges of posterior lower molars (Caucasus)..... *Microzeuglodon caucasicum*.

SQUALODONTIDAE.

Brain case telescoped. Molars with anterior or posterior cutting edges serrated by accessory cusps or tubercles. Crowns of molars ornamented with rugose enamel.

B². Anterior cutting edges of molars and premolars without accessory cusps (so far as known).

b¹. Enamel of crowns of molars ornamented with longitudinal striae, very coarse around base and finer toward apex. Crowns of premolars compressed (Germany)..... *Microcetus ambiguus*.⁶⁸

A². Molars of medium size; antero-posterior diameter of crowns more than 16 mm. and less than 30 mm.

B¹. Crowns of premolars ornamented with rugose enamel and provided with sawlike cutting surfaces⁶⁹ on at least one edge (so far as known).

⁶⁸ *Microcetus*, new genus for *Phoca ambigua* Meyer, 1840. The molars of *Microcetus* are quite unlike those of the other forms grouped under the Microzeuglodontidae. Perhaps they should be allocated with the Squalodontidae.

⁶⁹ The sawlike cutting surface referred to in this key should not be confused with the presence of accessory cusps. In the absence of accessory cusps, or when but one or two are present, the anterior and posterior edges of the cheek teeth of many of the squalodonts are transformed into carinae which are notched or toothed. An excellent illustration of this feature will be found on the plate accompanying De Zigno's article in the *Memoires del Istituto Veneto di Sci., Lett. ed Arti*, Venezia, vol. 20 for 1876. The teeth of this particular specimen, apparently, have this feature very strongly developed.

*C*¹. Molars (so far as known) with two roots.

*D*¹. Accessory cusps present on both anterior and posterior cutting surfaces of some of the molars.

*E*¹. Crowns of premolars not strongly compressed and provided with one crenulate cutting edge (so far as known).

*e*¹. Molars constricted below enamel crown.

*f*¹. Roots of molars united at base by a thin isthmus. Posterior cutting edge of at least one molar with five to six accessory cusps (Australia).

Metasqualodon harwoodi.

*e*². Molars not constricted below enamel crown.

*f*¹. Roots of molars divergent basally, not united by a thin isthmus. Posterior cutting edges of molars with four accessory cusps.

*g*¹. Accessory cusps on cutting edges of molars distinct, and projecting freely (Australia).....*Squalodon serratus*.

*g*². Accessory cusps on cutting edges of molars more closely approximating each other. Three or more of the molars in the mandible serrated by accessory cusps on both anterior and posterior cutting edges. Roots of molars short, converging distally and but slightly longer than height of crown (Malta).

Squalodon melitensis.

*f*². Roots of molars united by a thin isthmus for a considerable portion of their length and never widely separated; tips recurved. Roots of molariform teeth nearly twice the height of crown. Premolar with crenulate cutting edge. Enamel surface of molar crown ornamented with coarse anastomosing striae (Australia).

Parasqualodon wilkinsoni.

I. LONG-BEAKED GROUP.

Frontals in contact posteriorly with supraoccipital. Parietals excluded from vertex of skull.

*E*². Crowns of premolars strongly compressed, incurved, and provided with sawlike cutting surfaces on both edges. Enamel surface of molar crown ornamented with striae.

Rostrum elongated, equaling nearly twice the length of that portion of the skull posterior to maxillary notches. External nasal openings situated far posteriorly. Brain case telescoped. No intertemporal constriction. Supraorbital process of frontal expanded laterally, constricted proximally. Frontals in contact posteriorly with supraoccipital, and receive the ascending processes of premaxillae in paired grooves along the internal margins of maxillae. Nasals abbreviated, apparently synostosing with the frontals in old adults. Mesorostral channel open. Mesethmoid fills large frontal fontanelle; forms the thick partition separating the nasal passages externally; provides support for the abbreviated nasals; and is pierced by a second pair of passages, the foramina for the nasal or ophthalmic branches of the trigeminal nerve. Cheek teeth increased above the typical number 44; variable 58 to 60. Molars not exceeding seven and premolars five in either jaw.

SQUALODON

*F*¹. Both edges of some of the molars provided with sawlike cutting surfaces in addition to the accessory cusps.

*f*¹. At least five of the molars in each upper jaw with anterior and posterior cutting edges serrated by well-defined accessory cusps. Roots of molars connected near the base by a short thin isthmus.

- g*¹. Premolars slightly compressed; crowns recurved, the enamel ornamented with longitudinal striae.

$$\text{Dental formula: } i. \frac{3-3}{(? 3-3)}; c. \frac{1-1}{1-1}; pm. \frac{5-5}{4-4}; m. \frac{7-7}{6-6}.$$

Width of rostrum at narrowest point, 50 mm.; width of rostrum at base, 134 mm. Orbital apophysis of the supraorbital process of frontal pointed anteriorly. Mesorostral channel open. Mesethmoid forms a thick partition separating nasal passages superiorly, sheathes the dorsal and lateral faces of the presphenoid in the narial region, fills in the large frontal fontanelle and thus contributes to the formation of a pair of foramina which lead from the cranial cavity to the mesorostral channel, provides support for the vertex of the skull, and underlies the abbreviated nasals. Ascending processes of premaxillae extending posteriad to nasals. Supraoccipital wide, equaling nearly one-half of greatest width of skull across squamosals. Vomer appears in roof of palate as splintlike bone inserted between horizontal plates of the maxillae. Coronoid portion of mandible curved inward and distal portion outward; in consequence the alveolae shift with the postero-anterior curvature of the ramus from a horizontal to a lateral position. Width of tooth bearing portion of the ramus, 19.5 mm. to 27 mm. Symphysis extends backward to second molar and approximates the upper margin of the ramus anterior to alveolae for the last premolar. Ulna possesses a well-developed olecranon process (Maryland)..... *Squalodon calvertensis*, new species.

- f*². About one-half of the true molars in each upper jaw with anterior and posterior cutting edges serrated by well-defined accessory cusps.

- g*¹. Accessory cusps on the cutting edges of molars closely approximating each other; the four posterior molars unknown. Premolars slightly compressed; crowns lightly fluted.

$$\text{Dental formula: } i. \frac{3-3}{3-3}; c. \frac{1-1}{1-1}; pm. \frac{5-5}{4-4}; m. \frac{7-7}{? 5+}.$$

Length of rostrum in advance of maxillary notch more than twice length of cranium posterior to notch. Width of rostrum at anterior extremities of maxillae, 40 mm.; width of rostrum at base about 115 mm. Orbital apophysis of the supraorbital process of frontal truncated anteriorly (rather squarely). Mesorostral channel open. Nasals rudimentary. Frontals forming a relatively broad strip across the vertex and not conspicuously overlapped by the ascending processes of the maxillae. Ascending processes of premaxillae extending posteriad to external narial openings, the distance approximately equivalent to anterior breadth of exposed surface of frontals on vertex (Bavaria)..... *Squalodon zitteli*.

- g*². Accessory cusps on the cutting edges of molars projecting freely; well-defined cusps present on both anterior and posterior edges of the posterior molars. Enamel surface of molar crown roughly sculptured or ornamented with coarse striae (New Jersey).

Squalodon atlanticus.

- F*². Both edges of some of the molars not provided with sawlike cutting surfaces in addition to accessory cusps.

*f*¹. At least five of the molars in each upper jaw with anterior and posterior cutting edges serrated by well-defined accessory cusps. Molar crown high, ornamented with coarse striae (France).

Squalodon typicus, new species [= *Squalodon gratecroupii* Authors].

*f*². Less than five of the molars in each upper jaw serrated by well-defined accessory cusps on both cutting edges. Roots of some of the molars long, and in some instances there is an indication of a thin isthmus which is, however, short.

*g*¹. Molar crown high, slightly incurved toward apex. Molars not constricted below enamel crown. Enamel surface of premolars ridged or fluted.

*h*¹. Accessory cusps present on both cutting edges of posterior molars, though not prominent. Premolars with elongate conic crowns, slightly compressed, forming an obtuse angle with root; enamel surface of crown fluted. Roots of some of the premolars united by a thin isthmus for a considerable portion of their length. Roots of incisors lodged entirely in the premaxillaries; roots of canines lodged in maxillae

Dental formula: $i. \frac{3-3}{3-3}; c. \frac{1-1}{1-1}; pm. \frac{4-4}{4-4}; m. \frac{7-7}{6-6}$

*i*¹. Width of rostrum at base, 140-144 mm.; width of rostrum at anterior extremities of maxillae, 60 mm. Length of rostrum in advance of maxillary notch slightly less than twice length of cranium posterior to notch. Orbital apophysis of supraorbital process of frontal rounded. Frontals forming a narrow band across the vertex of skull, conspicuously overlapped by ascending processes of maxillae. Mesorostral channel open. Nasals rudimentary. Ascending processes of premaxillae extending slightly posteriad to external narial openings, the distance equivalent to less than anterior breadth of exposed surface of frontals on vertex. Supraoccipital wide, somewhat more than one-half greatest width of skull across squamosals, and forming a shallow "W" shaped outline superiorly (France).

Squalodon bariensis bariensis.

(Italy) *Squalodon bariensis bellunensis*.

*i*². Rostrum relatively wider at base. Frontals forming a wider band across the vertex of the skull. Supraoccipital apparently wider, rounded superiorly and not forming a "W" shaped outline (Italy).... *Squalodon bariensis latirostris*.

*D*². No accessory cusps on anterior cutting edges of molars (so far as known).

*d*¹. Molars not provided with sawlike cutting surfaces on either cutting edge.

*e*¹. Roots of molars divergent at base, not united by a thin isthmus.

*f*¹. Anterior and posterior cutting edges of premolars distinctly sawlike.

Incisors ornamented with coarse longitudinal striae or fluted. Roots of molars long, curving posteriorly and approximately equally distant from each other throughout their length; the roots are longer than maximum breadth of crown and the posterior roots of some of the molars equal more than twice the height of crown. Accessory cusps on posterior cutting edges of molars well developed.

Dental formula: $i. \frac{3-3}{3-3}; c. \frac{1-1}{1-1}; pm. \frac{5-5}{4-4}; m. \frac{7-7}{?6+}$ (Belgium).

Squalodon antverpiensis.

*e*². Roots of molars united by a thin isthmus for a portion of their length.

*f*¹. Roots of molars not strongly bifurcated; crowns high. Three to four accessory cusps on posterior cutting edge of molars (Germany).

Pachyodon mirabilis.

*d*². Molars provided with sawlike cutting surfaces on at least one edge.

*e*¹. Roots of molars divergent but connected at base by a short thin isthmus.⁷⁰ Enamel crowns of molars ornamented with coarse longitudinal striae. Anterior and posterior cutting edges of premolars indistinctly sawlike. Crowns of premolars slightly compressed and incurved; striae coarse at base and disappearing toward apex of crown. Incisors with very long, narrow, and fluted crowns. Nasal passages situated in advance of nasals, but their posterior margins lie in same plane as anterior margins of nasals. Ascending processes of the premaxillae extending as far as but hardly beyond posterior margins of nasals. Nasals reduced in size. Frontals forming a narrow strip across vertex of skull. Width of supraoccipital superiorly less than one-half greatest width of skull across squamosals. Descending free plates of basioccipital greatly reduced in extent. Vomer overlaps the basisphenoid and apparently extends backward to the basioccipital (Germany)..... *Arionius servatus*.

Squalodon meyeri.

Squalodon molassicus.

*e*². Roots of molars divergent basally, and not united by a thin isthmus.

Enamel of crown strongly rugose, characterized by anastomosing striae. Anterior edge of molar possesses a sawlike cutting surface on basal half of crown. Posterior cutting edge of molar tooth with three well-defined accessory cusps (Italy). *Rhytisodon tuberculatus*.

*C*². Molars (one or two) with three roots.

*c*¹. Anterior edges of premolars and some of the molars characterized by sawlike cutting surfaces.

*d*¹. Accessory cusps on posterior cutting edges of molars steplike; one of the three roots of at least one posterior molar recurved posteriorly to, or beyond tip of the middle root (Italy).... *Trirhizodon catulli* (Molin). (France) *Trirhizodon gervaisii*.

*d*². Accessory cusps on posterior edges of molars well defined and freely projecting; the first four molariform teeth lack well-defined accessory cusps on anterior edge; roots long, united by a thin isthmus for a short portion of their length (Italy) [Tuscany]... *Trirhizodon suessii*. (Italy) [Venetia] *Trirhizodon catulli* (Zigno.)

II. SHORT-BEAKED GROUP.

*Frontals separated from the supraoccipital on the vertex of the skull by the parietals.*⁷¹

*B*². Crowns of premolars not provided with sawlike cutting surfaces.

*C*¹. Molars not constricted below enamel crown. Anterior and posterior cutting edges of molars serrated by accessory cusps. Molariform teeth have crowns ornamented with coarse striae. Anterior teeth are single rooted, with coarse striae. Parietals separate the frontals from the supraoccipital by a narrow interval on the vertex of the skull. Skull with reduced intertemporal constriction.

⁷⁰ Probst, J., Jahreshefte d. Vereins f. vaterl. Naturkunde in Württ., pl. 1, 1885.

⁷¹ Abel, O., Sitzungsber. math.-naturw. Kl. Kais. Akad. der Wissenschaften Wien, vol. 121, pt. 1, text fig., p. 61, and pl. 1, 1912.

- c*¹. Molars united throughout their length by a thin isthmus, and two rooted. Five to six pairs of two-rooted mandibular teeth. Rostrum broad at base and very short. External nasal openings situated posterior to the maxillary notches. Maxillary notches narrow in consequence of the conspicuous antero-external projection of the maxillae as in physeterine whales. Nasals triangular in shape and partially roof over nasal apertures. Mesethmoid forms the thick partition separating the nasal passages externally, provides support for the abbreviated nasals, and sheathes dorsal and lateral faces of the presphenoid which in turn forms the plug across proximal end of mesorostral channel. Mesorostral channel open. Supraorbital process of frontal broad, expanded laterally. Supraoccipital narrow, equaling about one-half of greatest width of skull across the squamosals, emarginate superiorly. Parietals forming a narrow strip across the vertex. Premaxillaries bounding the nasals laterally, but not extending posteriad to them, and overlapping frontals on vertex to a slight extent. Zygomatic portion of squamosals bluntly truncated anteriorly. Maxillaries extending posteriad beyond tips of premaxillaries and in contact with parietals on vertex. Mandibular symphysis shorter than in *Squalodon*. Mandible short and laterally curved. Atlas is long anteroposteriorly with two superimposed transverse processes on either side, and possesses a stout median postero-inferior process for odontoid (Patagonia).....*Prosqualodon australis*
- C*². Molars constricted below enamel crown. Anterior and posterior cutting edges serrated by accessory cusps. Parietals separate the frontals from the supraoccipital by a wide interval on vertex of skull.

PATRIOCETIDAE.

Skull with reduced or no intertemporal constriction.

- D*¹. Crowns of molars low; cusps on posterior edges large, with bluntly rounded apices. Roots of molars not united by a thin isthmus, widely divergent basally. Crowns of incisors compressed and curved inward, their anterior and posterior cutting edges sharp. Enamel surface of molar crown ornamented with coarse striae.
- d*¹. Maxillae narrowly overlapping frontals mesally with splintlike ascending processes, and not extending posteriad to anterior margins of temporal fossae. Rostrum broad at base, and relatively short. Maxillary notches wanting. External nasal openings situated more anteriorly than in *Squalodon*. Supraorbital processes of frontal broad, expanded laterally. Premaxillaries bounding nasals laterally, overriding frontals mesally, and extending posteriad as far as anterior margins of parietals on vertex. Parietals forming a broad strip across the vertex. Supraoccipital narrow, equaling less than one-half greatest width of skull across squamosals, truncate superiorly. Zygomatic portion of squamosal tapering anteriorly. Mesorostral channel wide open. Occipital condyles large, their posterior margins produced beyond overhanging edges of temporal fossae (Austria)..*Patriocetus grateloupii*.

Patriocetus denggi.

AGOROPHIIDAE.

Skull with a distinct intertemporal constriction.

- D*². Crowns of molars high, triangular in outline; cusps on cutting edges small. Roots of molars united by a thin isthmus. Enamel surface of molar crown lightly sculptured.

- d¹. Maxillae broadly overlapping frontals and not extending posteriad to anterior margins of temporal fossae. Rostrum broad at base, short and stout. Maxillary notches reduced in extent. External nasal openings situated more anteriorly than in *Squalodon*. Supraorbital process of frontal broad, expanded laterally, its anterior margin rounded and its posterior produced backward as the tapering postorbital process. Premaxillaries bounding nasals laterally, overriding frontals mesally, but terminating in advance of anterior margins of parietals. Parietals form the intertemporal region of the skull. Supraoccipital subtriangular in outline, equaling at base more than one-half greatest width of skull across squamosals. Mesorostral channel open. Occipital condyles large, their articular faces and necks produced beyond posterior margins of temporal fossae (South Carolina).....*Agorophius pygmaeus*

DESCRIPTION OF A NEW SPECIES OF SQUALODON FROM THE
CALVERT CLIFFS, MARYLAND.

SQUALODON CALVERTENSIS, new species.

Type.—No. 10484, Division of Vertebrate Paleontology, United States National Museum. This specimen consists of a nearly complete skull, including the greater portion of the rostrum; the palatal region is imperfect, and the jugals are missing. One periotic is preserved. Four molars, three premolars, and four incisorlike teeth were found associated with the skull. A mandible, two dorsals, and three lumbar vertebrae, six isolated epiphyses of vertebrae, ten ribs and one ulna also belong to this specimen.

Type locality.—The occurrence is as follows: Near latitude 38° 40' and longitude 76° 32' on the western shore of Chesapeake Bay, about 2 miles south of Chesapeake Beach, Calvert County, Maryland. Shown on Patuxent Quadrangle or Patuxent Folio No. 152, United States Geological Survey.

Horizon.—The specimen was discovered and excavated by Norman H. Boss on July 8, 1921. It was dug from the cliffs 5 feet above the beach. The oyster shell stratum is not visible at this point and is probably well under the beach level. The specimen apparently was dug from Shattuck's zone 6 of the Calvert Miocene formation of Maryland.

SKULL.

Dorsal view.—The most obvious peculiarity of this skull (pl. 1) is the apparent expansion of the rostrum at the tip. Some doubt may exist whether this modification was a natural one or whether it was the result of pressure exerted by the overlying strata. The separation of the premaxillae may have occurred during the process of weathering subsequent to the animal's death and before it was covered by the sediments which insured its future preservation. The imperfect state of preservation of certain exposed parts of the skull lends some support to the latter view. Otherwise, the long-tapering rostrum presents essentially the same features as other previously

described long-beaked squalodonts. It comprises more than two-thirds of the total length of the skull and was originally still longer. The narrowest portion is slightly in advance of the middle. The mesorostral gutter was open the full length of the rostrum, though the premaxillae approximate each other so closely at a point anterior to the middle that it may have been nearly closed at this point. Distally, this gutter is formed entirely by the premaxillae, which meet mesally and ventrally in a linear suture in front of the alveolae or the first molars; proximally, the vomer and the premaxillae contribute to its formation. The dorsal margins of the mesorostral gutter are formed by the overhanging edges of the premaxillae.

In the squalodonts, in consequence of the prolongation of the snout into a beak, the vomer acquires a considerable length and is so placed as to afford support for the premaxillae as well as the maxillae, and on the base of the skull extends backward as far as the basisphenoid. The vomer disappears in the floor of the mesorostral gutter slightly in advance of the narrowest portion of the rostrum or above the alveolae for the second molars. It increases in width posteriorly, and in the region just anterior to the alveolae for the fifth molars takes part in the formation of the lateral walls. On either side it is in contact with the adjoining premaxilla, the surfaces being smoothly mortised into one another. This contact between the vomer and the premaxilla has its posterior limit at the anterior margin of the presphenoid.

The premaxillae are bowed, and approximate each other closest, as remarked above, at a point anterior to the middle of the rostrum. Just anterior to the premaxillary foramina the premaxillae commence to expand horizontally, and rapidly increase in width to a point 20 mm. in advance of the mesethmoid. From this point posteriorly, they diminish in width, the internal margins being deflected ventrally as they approach the external nasal passages. Posterior to the anterior margins of the nasals they send back splintlike ascending processes, which are lodged in deep paired grooves in the frontals on either side of the internal margins of the maxillae.

The mesethmoid does not rise to the level of the premaxillae. It forms a thick partition separating the nasal passages superiorly, fills in the frontal fontanelle, provides support for the vertex of the skull, and underlies the nasals. Ventrally, the mesethmoid sheaths or forms a thin veneer of bone around the dorsal and lateral faces of the presphenoid, thus lining the internal walls of the nasal passages superiorly. The pterygoids, apparently, send thin laminae of bone dorsally to sheath the external walls of these passages. The presence of a second pair of passages which open at the posterior end of the mesethmoid gutter and lead into the brain case is a matter of unusual interest. These foramina owe their distinctness to that portion of

the mesethmoid which incompletely fills in the large frontal fontanelle and supports the nasals, leaving a small pair of passages on either side. They are here interpreted as transmitting the nasal branches of the ophthalmic (V) nerve.

The dorsal surface of the skull is constituted largely by the maxillae and the premaxillae, and to a less extent by the frontals. The maxillae make up the greater part of the dorsal surface. They expand suddenly just posterior to the maxillary notches, forming what may be called the frontal plates. These partially roof over the temporal fossae. Each maxilla terminates slightly in advance of the supraoccipital posteriorly. The internal margin of the maxilla is in contact with the premaxilla for practically the entire length. The surface of the maxilla is slightly depressed opposite the nasals, but plane elsewhere. The free or external margin is thinner than the internal. The orbital plate of the maxilla does not completely cover the thick apophysis of the supraorbital process of the frontal but leaves a considerable portion of the latter exposed in front and at the side. The broad base of the rostrum is formed largely by the lateral expansion of the maxillae.

The cranial region of the skull is quadrilateral in outline. As remarked above, the frontal plates of the maxillae constitute the greater part of the dorsal surface, the lateral extensions of the frontals being concealed for the most part by these bones. The nasal bones do not overhang the nasal openings and are considerably shortened. Posteriorly, they are suturally united with the frontals. The nasals present a quadrangular outline, truncated anteriorly, and emarginate posteriorly.

The rostral or anterior wall of the brain cavity is composed largely of a vertical sheet of bone formed by the paired frontals. Between these is a large frontal fontanelle which as it closes is filled in by the mesethmoid. Support to this view is lent by the figures of *Squalodon zitelli*.⁷² The fontanelle is still open in Zittel's specimen. The element labeled *pa.* [= parietal] in his figure is really the supraoccipital. The Maryland squalodont and Zittel's specimen admirably supplement each other and there is little chance for error in defining the relations of the various bones. Each frontal sends back a thin isthmus which unite by suture along the median line and form the vertex of the skull. Posteriorly, they are in contact with the supraoccipital and anteriorly are synostosed with the nasals. Laterally and at a lower level than the vertex the frontals widen out, support the maxillae, and give rise anteriorly to the supraorbital processes. The apophyses of the supraorbital processes are rather pointed, the

⁷² Zittel, K. von, *Palaeontographica*, Stuttgart, vol. 24, pl. 35, figs. 1 and 3, 1876-77.

internal margin sloping obliquely toward the cranium, the external more rounded and less declivent.

The maxillary notch formed by the angle between the apophysis or preorbital portion of the supraorbital process of the frontal and the adjoining portion of the maxilla is deep and acute. The maxillary foramina are situated 30 mm. in advance of the maxillary notches.

Posterior view.—As seen from the occipital view (pl. 4) the supraoccipital takes the form of a wedge-shaped bone, wider above than below. The conspicuous development of the lambdoidal crest is the characteristic feature of the back of the skull. Superiorly, the crest is formed by the margin of the supraoccipital which abuts against the frontals. On the inner sides of the temporal fossae the crest curves ventrally and laterally, following the contour of the posterior margins of the fossae.

The exoccipitals are rather large, coalesced with the supraoccipital above and projecting outward and backward like wings of the former. The external margins are rounded. Laterally and anteriorly they are in contact with the squamosals, while below they are fused internally with the basioccipital. The sharp-edged lambdoidal crest overhangs the exoccipitals on either side.

The opening for the foramen magnum was originally circular. The occipital condyles are semielliptical in outline with their long axes directed dorso-ventrally. They are strongly convex from side to side. The internal margins are concave and sharply defined, converging inferiorly. The external margins of the condyles are not set off from the exoccipitals by shallow concavities, but gradually merge into the exoccipitals. Ventral to the condyles and internal to the exoccipitals are the descending free plates of the basioccipital. Ventral to the temporal fossae and external to the exoccipitals are the large squamosals and their zygomatic processes.

Lateral view.—The lateral aspect (pl. 3) of the rostrum is formed almost entirely by the maxilla, though the tip was presumably made up by the premaxillae alone. The thickness of the broken anterior edge of the maxilla indicates that it extended some distance farther forward, how far, can only be surmised by comparison with other described forms. This view best illustrates the upturning of the anterior half of the rostrum which imparts a peculiar bowed appearance to the superior outline of the skull.

The skull as a whole is rather slender, and the height at the vertex is proportionately low in comparison with that of the base of the rostrum. A large alveolar gutter, with the septa between the alveolae formed of porous bone, terminates 62 mm. in advance of the maxillary notch. The supraorbital process of the frontal is concave above and below. The preorbital process or apophysis is rounded; the post-orbital process is abruptly truncated and sharp edged.

The zygomatic process of the squamosal is slender, curved, and tapering anteriorly. The postglenoid process is thin, directed more downward than backward. The temporal fossa is quite large, with the superior margin formed by the frontal and the overlying maxilla. In either temporal fossa the parietal is suturally united inferiorly with the squamosal, anteriorly with the frontal, and superiorly is synostosed to the thick lateral margins of the supraoccipital, forming an apparently continuous surface. The parietals are thus excluded from the dorsal surface and from the vertex of the skull.

A close examination of the surface of the cranium in the left temporal fossa shows a fissure in front of the squamosal and at its anteriormost point of contact with the parietal. This fissure is partially filled in by a triangular wedgelike bone which is interpreted to represent the ala temporalis or alisphenoid. The position of this bone and its relations to the surrounding elements correspond in all essential details with the same element in the skull of a foetal *Balaenoptera* in the United States National Museum. Unfortunately, the cranium on the right side is so badly broken in the region of the temporal fossa that no additional information can be obtained from that side of the skull regarding the relations of the alisphenoid to the other bones. In front of the parietal and above the aforementioned fissure, the frontal takes part in the formation of the lateral wall of the cranium.

Viewed from the side the condyles project beyond the plane of the exoccipitals. The skull has not been restored in the palatal region. The palatines and pterygoids, if present, would impart a slightly different appearance to this part of the skull.

Ventral view.—The basioccipital is a relatively narrow bone with ventral surface concave from side to side, and terminated posteriorly by the paired condyles. Anteriorly, it is synostosed with the basi-sphenoid. The sides of the basioccipital are prolonged downward into free plates, which are characterized by convex swellings on internal and external sides. In this feature this skull (pl. 2) differs from the type of *Squalodon bariensis*.⁷³ In the latter, the descending plates are reduced in extent and are much longer anteriorly than posteriorly. These plates in *Squalodon bariensis* also join the pterygoids in front, which are hollowed out inferiorly to form the palatine vacuities. A close examination of the skull of the squalodont from Maryland reveals features which might suggest a different type of architecture in the palatine region. Since the palatines and the pterygoids are completely missing from this specimen there is no opportunity for further comparisons.

The descending plates of the basioccipital serve as the internal walls for the scaphoid fossa, the anterior and outer boundaries of

⁷³ Lortet, L., Archiv. Mus. d'Hist. Nat. de Lyon, vol. 4, pl. 25bis, 1887.

which are furnished by the descending lateral wings of the basisphenoid, and the squamosal. A large and well-marked groove which originates within the cranial cavity follows down the external face of the descending plate of the basioccipital along its line of union with the exoccipital. This is interpreted to be the posterior lacerated foramen. Condylar foramina are present on either side of the basioccipital.

The basisphenoid is flat in comparison to the basioccipital and the anterior margin was concealed to some extent by the vomer and the vaginal plates of the internal pterygoids. If the sutures have been correctly ascertained the basisphenoid does not enter into the formation of the lateral descending plates of the basioccipital except at the base and then only in front of the line of contact between these two elements.

The presphenoid is permanently separated from the basisphenoid by an open transverse suture, apparently paralleling in this respect *Squalodon zitteli*.⁷⁴ This region in the skull of *Squalodon bariensis* is concealed by the vomer and the adjoining vaginal processes of the internal pterygoids. The posterior end of the vomer as preserved in the Maryland squalodont commences 112 mm. in advance of the foramen magnum. As remarked above, the imperfect state of preservation of this portion of the skull prevents accurate description. However, the free ends of the palatine plates of the maxillae show that the palatines were suturally united to the former, and that they did not extend as far forward as the maxillary notches. On the other hand Lortet's figure of *Squalodon bariensis* suggests that the palatines may have terminated in front of the maxillary notches.

The vomer first makes its appearance on the ventral surface of the skull as a splintlike bone inserted between the palatine plates of the maxillae, commencing near the alveolae for the second molars and disappearing on a line with the seventh as in *Squalodon zitteli*. It again makes its appearance posterior to the internal openings of the nasal passages. In order to insure a correct contact between the two major portions of the matrix during the preparation of this specimen it was necessary to fill in this portion of the skull with plaster of Paris, and no attempt was afterwards made to restore these passages to their natural appearance. The vomer is characterized by a well-developed carina, though this, presumably, is merely a posterior continuation of the ascending plates that sheath the internal walls of the nasal passages inferiorly.

The squamosals are produced outward and the zygomatic processes thus formed do not closely approach the posterior part of the supra-orbital processes of the frontals as in *Squalodon bariensis*, but are

⁷⁴ Zittel, K. von, *Palaeontographica*, Stuttgart, vol. 24, pl. 35, fig. 3, 1876-77.

separated by a wide interval. The squamosal is firmly fixed to the side of the skull and internally forms part of the wall for the cranial cavity. The petrous portion of the squamosal fills in most of the tympano-periotic recess and internally is suturally united to a lateral wing of the basisphenoid. The posterior and outer part of the squamosal is produced downward into a thin lamina or postglenoid process. The glenoid surface of the squamosal is rather wide and concave from side to side. Behind the glenoid process is a blunt knob-like tuberosity, between which and the postglenoid process is a broad channel while behind this knob or rather between it and the exoccipital, there is a narrower and deeper groove or suture. The channel on the squamosal posterior to the postglenoid process is the groove for the external auditory meatus, which continues its course upward in a deep depression on the posterior face of the postglenoid process of that bone, and terminating some 70 mm. above the tip of that process.

In *Squalodon bariensis* the jugal extends from the maxillary notch to the antero-inferior margin of the zygomatic process of the squamosal. The broken edges and the roughly sculptured surface of the posterior margins of the lacrymals of the Maryland squalodont indicates that the jugal occupied a similar position.

The horizontal ventral plates of the maxillae contribute largely to the formation of the roof for the oral cavity. They are separated from each other for most of their length by the splintlike strip of vomer, and are in contact only posterior to the alveolae for the last molars. Their surfaces are strongly convex posteriorly, and taper rapidly anteriorly. The maxillae are not prolonged over the ventral faces of the supraorbital processes of the frontals. The presence of the lacrymal makes such an extension impossible.

In the zeuglodonts⁷⁵ the lacrymal occupies a position at the base of the rostrum and on the external margin of the supraorbital process; it is bounded posteriorly and internally by that process, and anteriorly by the maxilla. A change in the architecture of the skull from the zeuglodont to the squalodont type, particularly in the rostral region, and the resulting constriction of the base of the rostrum and formation of the maxillary notches, would result in the shifting of the lacrymal to a more internal position. If the sutures which bound a small area on the right maxilla are real and not apparent, then the position of the lacrymal in the Maryland squalodont is in accordance with what would be expected in such a modification and its relation to the adjoining bones remains unchanged. Some squalodont skull in a better state of preservation may show that the above interpretation is incorrect, for in the Iniidae the

⁷⁵ Andrews, C. W., A descriptive catalogue of the Tertiary vertebrata of the Fayûm, Egypt. London, text fig. 80, p. 244, 1906.

lachrymal is a small wedgelike bone which fills the interval between the posterior margin of the ventral plate of the maxilla and the supraorbital plate of the frontal.

PERIOTIC.

The right periotic (pl. 8, figs. 5-6) of *Squalodon calvertensis* differs considerably from that of *Eurhinodelphis longirostris*⁷⁶ and possesses many of the structural peculiarities exhibited by those of *Delphinodon dividum*⁷⁷ and *Prosqualodon australis*.⁷⁸ The bone may be described as irregularly triangular. The posterior end, or mastoid process of petrosal, is short and stout, while the anterior end of the petrosal resembles a twisted cone. On the ventral face of the anterior process

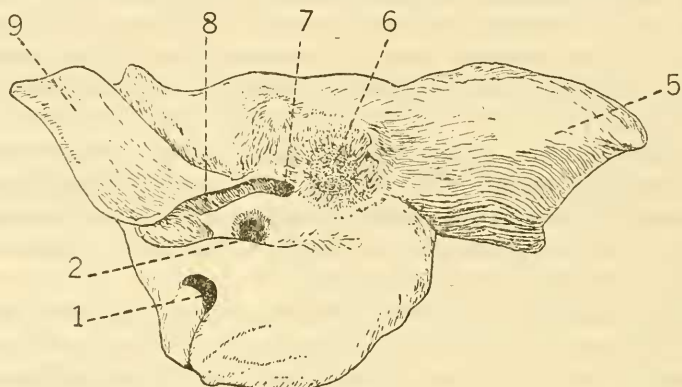


FIG. 1.—DORSAL VIEW OF RIGHT PERIOTIC OF *SQUALODON CALVERTENSIS*, NEW SPECIES. X2. No. 10484, U.S.N.M.; CALVERT CLIFFS, MARYLAND. THE SAME NUMBERS ARE USED IN FIGURES 1 TO 3 FOR THE FOLLOWING PARTS: 1, FENESTRA ROTUNDUM; 2, FENESTRA OVALIS; 3, EXTERNAL APERTURE OF AQUAEDUCTUS COCHLEAE; 4, EXTERNAL APERTURE OF AQUAEDUCTUS VESTIBULI; 5, PROCESSUS ANTERIOR PETROSI; 6, PIT FOR HEAD OF MALLEUS; 7, TYMPANIC APERTURE OF FACIAL CANAL; 8, SEMICLOSED CANAL FOR FACIAL NERVE, WITH GROOVE FOR STAPEDIAL MUSCLE; 9, PROCESSUS POSTERIOR PETROSI (MASTOID PROCESS, IN PART); 10, INTERNAL ACOUSTIC MEATUS; 11, FORAMEN CENTRALE; 12, FORAMEN SINGULARE; 13, INTERNAL OR CEREBRAL APERTURE OF FACIAL CANAL.

of the petrosal there is a circular depression in which the head of the malleus is lodged. The malleus, presumably, was united with the tympanic and situated anterior to the caudal lip of the bulla. The mastoid process of the petrosal fits loosely into a notch on the squamosal, yet the contact shows that correct relations were maintained with the open channel for the external auditory meatus. The anterior face of this process is hollowed out. The pedicle on the posterior end of the tympanic rests on the flattened and rectangular ventral face of the mastoid process of the petrosal.

A thin ledge is formed by the internal prolongation of the inferior margin of the mastoid process of the petrosal which partially roofs

⁷⁶ Abel, O., Mém. Mus. Roy. Hist. Nat. Belgique, Bruxelles, vol. 2, fig. 19, p. 122, 1902.

⁷⁷ True, F. W., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, p. 175, pl. 25, figs. 6-11, 1912.

⁷⁸ True, F. W., Smithson. Misc. Coll. (Quart. Is.), vol. 52, pt. 4, Publ. 1875, fig. 78, p. 452, 1909.

the fallopian or facial canal posteriorly. The tympanic cavity of the internal ear of this squalodont periotic is limited externally by this crest. The deep and narrow groove which forms the facial canal commences on the posterior margin of the periotic and leads to the opening for the fallopian tube. The fenestra ovalis lies below this canal and on the lateral face of the labyrinthine portion of the periotic. The duct passes obliquely upward. The absence of any stapes suggests that it was not firmly fixed as in some of the whalebone whales. Perhaps an annular ligament held the stapes in place since it did not completely fill the fenestra ovalis with its foot plate.

The inferior half of the central portion of the periotic corresponds to the labyrinthine region. On the posterior end of this structure there is a semicircular opening, the fenestra rotundum. A rounded promontory is formed above this opening by the closure of an open groove, which, at some time during this cetacean's growth, extended across the posterior face of the labyrinthine and opened on the internal face. This groove represents the common opening of the fenestra rotundum and the external aperture of the aquaeductus cochleae. A small canal connecting the fenestra rotundum with the external aperture of the aquaeductus cochleae remains open. The apertures for the facial canal, fenestra ovalis, fenestra rotundum, and the external aperture of the aquaeductus cochleae, as well as the course of the facial canal are practically identical in position with those of *Delphinodon*.

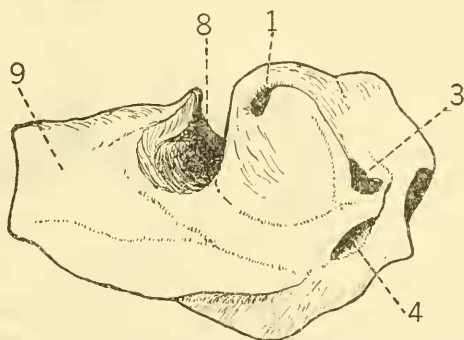


FIG. 2.—POSTERIOR VIEW OF RIGHT PERIOTIC OF SQUALODON CALVERTENSIS, NEW SPECIES. $\times 2$. No. 10484, U.S.N. M.; CALVERT CLIFFS, MARYLAND.

On the dorsal face and near the posterior margin is a partially closed suture which presumably marks the line of contact between the mastoid and the labyrinthine portions of the periotic.

The most noticeable feature of the internal face is a large elliptical opening, the roof of which defines the limits of the labyrinthine and petrous portions of the periotic. Within this opening a thin bony partition separates the aperture for the facial canal from a deep and more centrally placed fossa. This fossa represents the internal acoustic meatus which receives the acoustic nerve and the internal auditory artery. At the bottom of this fossa is the tractus spiralis foraminosus, but this structure is barely visible. A small foramen is present at the top of the previously discussed bony partition and leads into the vestibular portion of the periotic. This could trans-

mit the vestibular branches of the acoustic nerve and the internal auditory artery. It may, perhaps, represent the foramen singulare which gives passage to the nerves for the ampullae. On the floor of the acoustic meatus is a small foramen which enters the cochlear portion of the periotic. If the homologies are correct this would be the foramen centrale and would afford passage for the cochlear branches of the acoustic nerve. The meatus is approximately 8 mm. deep and 4.5 mm. wide. The passage anterior to the internal acoustic meatus as already stated represents the internal opening of the facial canal or fallopian tube, which appears in the epitympanic recess as described above, and pierces the periotic obliquely.

On the posterior margin of the periotic and superior to the acoustic meatus there is an opening which is interpreted to represent the external aperture for the aquaeductus vestibuli.

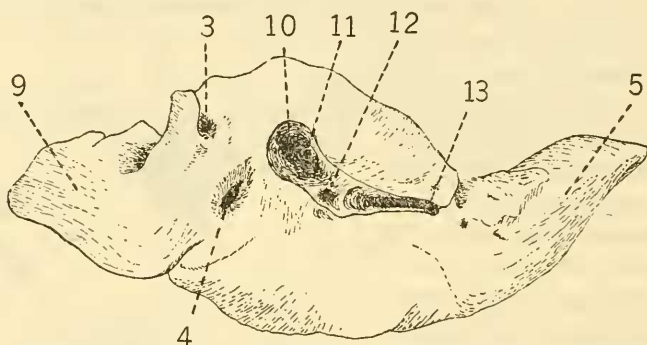


FIG. 3.—INTERNAL VIEW OF RIGHT PERIOTIC OF *SQUALODON CALVERTENSIS* NEW SPECIES. $\times 2$. No. 10484, U.S.N.M.; CALVERT CLIFFS, MARYLAND.

The dorsal surface of the anterior process of the petrosal rests against the petrous portion of the squamosal and the anterior margin is in contact with the internal pterygoid process of the alisphenoid. Internally, the anterior process is so intimately fused to the posterior process of the petrosal that they are unrecognizable as separate elements.

MANDIBLE.

The lower jaw is quite large in comparison with the size of the cranium and its general conformation is similar to those of other described squalodonts. Back of the last molar the rather delicate coronoid rises abruptly, and near the same point the inferior margin of the ramus is deflected downward; in consequence the coronoid is quite deep and strongly convex on the external face. Little more can be said concerning this portion of the mandible for the angle and the condyle are both missing. A long symphysis extends back to a point beneath the anterior margin of the alveolus for the second molar. The tooth-bearing portion of the lower jaw is relatively

shallow, and consists of a thin shell of bone. Posteriorly the frame diminishes in thickness and in the region anterior to the coronoid, and on the internal face it is no thicker than blotting paper and very fragile. The internal portion of the ramus consists of an expanded papyraceous area opened for the whole length of the mandible by an enormous inferior dental canal. The proximal portion of the mandible is deep and thin, gradually tapering in depth rostrally though increasing in width. The external surface is convex and the internal somewhat flattened. The coronoid portion of the mandible curves inward and the distal portion outward. The alveolae shift with the postero-anterior curvature of the mandible from a horizontal to a lateral position.

In general outline the mandible of this Maryland squalodont recalls *Squalodon zitteli*⁷⁹ from the Miocene of Bavaria. The length of the symphysis, the proportions of the ramus, and the large size of the anterior alveolae are features common to both specimens.

TEETH.

More than 50 years ago two fragments of a squalodont skull, obtained from the Calvert formation of Charles County, Maryland, were submitted to Cope by James T. Thomas. Each of these fragments possessed three serrate two-rooted molar teeth. In describing these teeth, Cope⁸⁰ compares them with two European species and then concludes they are referable to Leidy's form *Squalodon atlanticus*. The measurements given by Cope and the figures accompanying Leidy's⁸¹ report agree with the size of the alveolae of the skull discussed in the present paper. Certain features pointed out by Cope and Leidy, such as the "more elevate conic apex" of the crown and the "less strongly wrinkled" enamel, suggest a close relationship with the present species. On the whole there is considerable resemblance between Cope's squalodont and *Squalodon calvertensis*, taking into consideration the size and shape of the teeth, the ornamentation of the enamel, and the number of accessory cusps. In addition, these two specimens were obtained from deposits belonging to the Calvert formation.

The squalodont described by Cope and the present specimen are quite different from *Squalodon atlanticus*. The four teeth shown on Leidy's plate represent the third to the sixth molars, inclusive, judging from comparative measurements and size of the accessory cusps. These molars are not represented among the teeth preserved with the skull under discussion. Eleven isolated teeth were found embedded in the matrix surrounding the skull. An examination of the alveolae of the skull and mandible shows that the teeth were implanted ob-

⁷⁹ Zittel, K. von, Palaeontographica, Stuttgart, vol. 24, pl. 35, figs. 1, 3, 1876-77.

⁸⁰ Cope, E. D., Proc. Acad. Nat. Sci. Philadelphia [vol. 19], pp. 132, 153-154, 1867.

⁸¹ Leidy, J., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, pl. 30, fig. 13, 1869.

liquely and that the posterior root usually underlies the anterior root of the following tooth.

A nearly perfect specimen of the last lower molar on the right side is represented in Figure 1, Plate 7. It conforms to the size and peculiar shape of this alveolus in the mandible, and there seems little or no chance for error in relegating the tooth to this position. Furthermore, it agrees in all essential details of form with similar last molars of previously described squalodonts.⁸²

The crown is low and roughly sculptured or covered with longitudinally striate enamel. The main cone or apex of the crown is depressed and bent backward. The anterior cutting edge slopes obliquely backward and is serrated by two low blunt accessory cusps, which incline in the direction of the main cusp, as well as by several small tubercles. On the posterior margin there are two well-defined cusps, one freely projecting and situated near the base of the crown, the other closely appressed to the main cone or apex of the tooth. The roots are short and stout. They are widely separated at the base and diverge rapidly, the anterior root being recurved distally.

The serrulated cutting edges of the second left upper molar (pl. 7, fig. 2) conform to the type of tooth which would be needed to supplement the series shown by Leidy's figure. The enamel surface is ornamented by a rugose network of striations which tend to assume a longitudinal arrangement on the apical portion of the crown. These striae are coarse toward the base and become finer toward the summit. The two accessory cusps on the anterior edge of the crown are restricted to the basal portion; they are low steplike and incline in the direction of the main cone. The three cusps on the posterior edge project freely and are provided with sharp edges. They are nearly equal in size. The apical half of the crown is not serrated by additional cusps, but the anterior and posterior margins exhibit indistinct sawlike cutting surfaces. The posterior root is longer and stouter than the anterior. The roots are connected by a short thin isthmus at the base and do not diverge to any marked extent distally. Cope remarks that the roots of the molars of his squalodont were connected by a thin lamina at the base. *Squalodon atlanticus* lacks this modification.

An incomplete second upper molar (pl. 7, fig. 4) from the opposite side of the skull exhibits no additional features. The anterior half of the crown is broken off.

The allocation of some of the following teeth must be regarded as more or less provisional, for all the alveolae can not be opened sufficiently to insert the roots of the teeth for their full length. Certain of the alveolae are obstructed or closed by fragments of the sur-

⁸² Dal Piaz, G., *Palaeontographica Italica*, Pisa, vol. 6, pl. 26, fig. 3, 1900.

rounding bone which piece the walls of the alveolae, and all are filled in with the surrounding matrix. The specimen is so fragile that an attempt to remove these obstructions would probably result in serious damage to the skull and mandible. However, in so far as conditions permitted, the teeth have been fitted to their respective alveolae where present.

The second lower molar (pl. 7, fig. 3) on the right side is characterized by a high and pointed crown which lacks accessory cusps on the anterior margin. The enamel surface exhibits the same ornamentation as the other molars. The posterior margin bears two closely appressed accessory cusps. The roots are long and at the base are connected by a short thin isthmus. The posterior root projects more downward than backward, and the anterior root recurves distally.

In considering the premolars certain features are apparent at first glance. The crowns are shorter and the roots approximate each other more closely than in the molars. They are characterized by high compressed crowns and are provided with sawlike cutting surfaces on the anterior and posterior edges. One of these, the fourth upper premolar on the left side (pl. 7, fig. 5), bears two well-defined cusps on the posterior margin. The roots of the premolars are connected by a thin isthmus of varying extent. In the above-mentioned tooth the distal one-third of the anterior root is free, while only the very tip is not so united in the fourth right lower premolar (pl. 7, fig. 7). The curvature of the crown and the appearance of the enamel of the third right lower premolar (pl. 7, fig. 6) is essentially the same as the others.

The posterior roots of the premolars tend to become bent backward. The roots are relatively very long, and the oblique position they assume in the alveolae of the shallow jaws does not allow a deeper implantation than the inferior dental canal, and in consequence the ends of the posterior roots are forced to assume a horizontal position.

Four teeth (pl. 8, figs. 1-4) remain to be discussed. Notwithstanding the general resemblance of these teeth to the incisors, there appears some difficulty in deciding whether one or more may not represent a canine tooth. They all possess compressed and slightly recurved crowns. The enamel is longitudinally striate and the cutting surfaces are sharp edged. The roots are long and curve backward. A close examination of the curvature of these four teeth and a comparison of the positions they assumed when inserted in the alveolae of the skull and mandible resulted in assigning three of them to the upper jaws. If this determination is correct, then one (pl. 8, fig. 1) probably represents a lower canine tooth.

VERTEBRAE.

Five vertebrae were found associated with the skull and mandible. Of these two are dorsals, the others lumbar; all of the vertebrae lack epiphyses. Six epiphyses (pl. 13, figs. 3-4; pl. 14, figs. 1-2; pl. 15, figs. 1-2) were found embedded in the matrix. The vertebrae are very soft and porous, and were with difficulty extracted from the matrix.

The dorsals differ noticeably from those of *Delphinodon* and to a less extent from those of *Eurhinodelphis*. A comparison of these vertebrae with the dorsal series of *Inia geoffrensis* shows that one (pl. 9, figs. 1-3) unquestionably represents one of the more anterior dorsals; the other belongs near the end of the series. The structural peculiarities and the general appearance of the anterior dorsal suggest the second dorsal. If this determination is correct, then certain peculiar features are accentuated. Using the length of the centrum as a basis for allocation, this vertebra would be placed fourth or fifth in the dorsal series. However, the position of the articular facet for the head of the rib and the small size of the anterior facets for the postzygapophyses of the preceding vertebra would place the vertebra anterior to the fourth dorsal.

It differs from an anterior dorsal of *Eurhinodelphis* in having a longer neural spine, a relatively larger neural canal, lighter neural arches, and in the possession of a deep groove on the lower half of the posterior face of the neural spine. The anterior dorsals of *Inia geoffrensis* also possess neural spines with similar grooves.

The centrum, including the epiphyses, was nearly as thick as broad. The neural canal is large and rounded, almost as large as the centrum. The zygapophyses are not developed as distinct processes, but are limited to articular surfaces for the corresponding processes of the adjoining vertebrae. The anterior facets are situated on the internal margins of the neurapophyses and the posterior on the ventral faces of the same arches.

The transverse processes or diapophyses are short and blunt, directed outward and slightly forward. The neural spine is broken superiorly.

The other dorsal vertebra (pl. 10, figs. 1-3) to be discussed occupied a more posterior position in the series than the preceding. The transverse processes are shortened and are so situated that their long axes are in a line with the top of the centrum. Each process bears a facet for the head of a rib. In *Inia geoffrensis* the facet for the head of the rib shifts from the anterior margin of the neural arch on the first dorsal to the top of the centrum on the eleventh dorsal. This feature occurs also in other cetaceans, and if any reliance can be placed on it then this vertebra is the eleventh in the dorsal series. The twelfth dorsal of *Inia* bears a facet on the tip of the flattened transverse proc-

ess and the tenth exhibits the line of fusion of the diapophysis with the parapophysis.

The facets for the post zygapophyses of the preceding vertebra are large and well developed, sloping obliquely internally and ventrally. The prezygapophyses have been broken off but were, apparently, large processes. The neural canal is much smaller than that of the anterior dorsal. An increase in the depth as well as length of the centrum should be noted.

The three lumbar found with the skull are imperfectly preserved. The first and second lumbar vertebrae (pl. 11, figs. 1-2; pl. 12, figs. 1-2; pl. 13, figs. 1-2) possess complete neural arches and the lower portion of the neural spine. The neural arch does not occupy the full length of the centrum and the posterior margins of the arch are strongly concave. The prezygapophyses were large as originally preserved but in the vertebrae under discussion only the broken edges reveal their former presence. The transverse processes are thin and are narrower than the centrum. The distal ends of all are broken or damaged in some way. The neural canal is narrow and high. The third lumbar is so badly damaged that little can be said concerning it.

RIBS.

The number of pairs of ribs possessed by this squalodont can not be determined definitely from the material at hand, which is limited to 10 ribs. It appears, however, that there were present originally at least 11 pairs of ribs. The whole ribs and fragments were carefully compared with associated skeletons of living cetaceans and the following determinations are advanced tentatively.

A considerable portion of the first rib (pl. 16, fig. 1) belonging to the left side is preserved. It is relatively thin, broad, and somewhat flattened, and the curvature at the broken end indicates that it was slightly expanded distally. The articular facets on the head and the tubercle are present but are poorly defined. The neck is relatively narrow. The proximal portion is bent at right angles to the shaft and the neck is turned inward. The left rib (pl. 16, fig. 2) of the second pair of ribs is in a better state of preservation than some of the others and the shaft is more nearly of equal width throughout. The tubercle is well developed, the neck shortened, and the shaft slightly thickened. The distal end is rounded and the surface for the sternal cartilage is lightly pitted. The third rib (pl. 16, fig. 3) belonging to the left side shows a narrowing of the neck and a slight reduction in the extent of the tubercle. The curvature of the shaft is more even, and the angle is not so noticeable as in the first and second ribs.

The rib which is assumed to represent the fourth on the right side (pl. 16, fig. 8) exhibits a noticeable lengthening of the neck and a nar-

rowing of the head. A well-defined facet represents the tubercle. There is a marked lengthening of the shaft. A shortening of the neck which accompanies the uplifting of the head tends to impart a more even curvature to the shaft of the fifth rib (pl. 16, fig. 4) on the left side. The angle formed by the neck with the shaft is most noticeable in the first rib as remarked above and becomes less acute in each succeeding rib. The shaft in the region of the tubercle is considerably narrower than the third and slightly less than the fourth rib. This narrowing of the rib in the region of the tubercle and shortening of the neck is carried even further in the sixth rib (pl. 16, fig. 5) belonging to the left side. The eleventh rib (pl. 16, fig. 6) resembles in some respects the same rib of *Inia geoffrensis*. The shaft is a little wider than some of the preceding ribs. The head is squarely truncated; the shaft is expanded near the center of the proximal half and the distal end is so twisted that it is at right angles to the proximal end of the shaft.

ULNA.

In general outline, the ulna (pl. 6, fig. 2) differs somewhat from that of *Basilosaurus cetoides*.⁸³ The shaft is proportionately shorter; the olecranon process and the proximal end of the ulna beyond the open greater sigmoid cavity are relatively smaller. This cavity on the anterior face of the ulna possesses an indistinct margin superiorly and the slope of the articular surface would permit considerable freedom of movement of the paddle. The olecranon process is not perfectly preserved, and what remains of the original surface is sufficient to justify the assumption that the original form was essentially similar. On the anterior face of the ulna and immediately below the sigmoid cavity is a depressed articular surface for the corresponding portion of the radius. The shaft of the ulna is relatively stout, quite broad, and thin. The anterior face of the shaft is rounded; the external and internal faces converge posteriorly to form a thin margin. The surface of the bone is smooth and the distal end is squarely truncated.

MEASUREMENTS FOR THE SKULL.

	<i>mm.</i>
Total length of skull as preserved.....	750
Length of rostrum as preserved (maxillary notch to tip of beak).....	485
Greatest breadth of skull across supraorbital processes.....	270
Greatest breadth of skull across zygomatic processes of squamosal.....	290
Vertical height of skull (between tip of descending free plate of basioccipital and frontals on the vertex of the skull).....	174
Vertical height of skull (basisphenoid to frontals on vertex of skull).....	123
Greatest height of skull at base of rostrum (across maxillary notches).....	76.5
Total length of maxillae as preserved	578
Greatest breadth across premaxillae at line of anterior margin of mesethmoid.	90
Greatest breadth across premaxillae at line of anterior margin of nasals.....	68

⁸³ Gidley, J. W., Proc. U. S. Nat. Mus., vol. 44, No. 1975, fig. 1, p. 651, 1913.

	mm.
Greatest breadth across premaxillae at narrowest portion of rostrum	19
Greatest breadth of right premaxilla in front of mesethmoid	36
Greatest breadth of right premaxilla at distal end as preserved	16.5
Narrowest breadth of right premaxilla near middle of rostrum	10±
Breadth of rostrum at maxillary notch	134
Breadth of rostrum at narrowest point	50
Breadth across rostrum at swelling in front of maxillary notch	125
Length of right frontal plate of maxilla (maxillary notch to supraoccipital) ..	166
Greatest breadth of right frontal plate of maxilla	70±
Least distance across vertex of skull between inner margins of maxillae	58
Greatest length of left supraorbital process of frontal	108
Greatest thickness of preorbital portion of right supraorbital process	28
Least breadth of cranium between temporal fossae	121±
Distance from vertex to upper margin of foramen magnum	123
Height of foramen magnum (crushed)	36+
Greatest breadth across occipital condyles	95
Greatest diameter of right condyle	50
Distance across skull between outer margins of exoccipitals	235
Greatest diameter of zygomatic process of right squamosal	106
Greatest diameter of zygomatic process of left squamosal	108
Distance between tip of right zygomatic process and postorbital portion of supraorbital process	42
Distance between tip of left zygomatic process and postorbital portion of supraorbital process	64
Distance between anterior margin of apophysis of supraorbital process of frontal and posterior margin of right condyle	281
Distance between anterior margin of apophysis of supraorbital process of frontal and posterior margin of left condyle	292
Greatest breadth of basioccipital across tips of descending free plates	112.5
Distance between anterior margin of foramen magnum and anterior margin of basisphenoid	93
Greatest superior breadth of supraoccipital	150
Total length of vomer as preserved	417
Total length of vomer, estimated	440
Greatest length of right nasal	21
Greatest breadth of right nasal	28
Greatest length of exposed portion of right frontal on vertex of skull	31
Greatest breadth of exposed portion of right frontal on vertex of skull	31

MEASUREMENTS FOR THE MANDIBLE.

Length of mandible as preserved	604
Depth of mandible at coronoid	152
Least depth of mandible at alveolus for third lower premolar	36
Least breadth of tooth-bearing portion of the mandible	19.5
Greatest breadth of tooth-bearing portion of the mandible	27
Depth of mandible at level of last molar	53

MEASUREMENTS FOR THE PERIOTIC.

Greatest length of periotic (tip of anterior to tip posterior process)	41.5
Greatest depth of labyrinthine region of periotic	15.5
Greatest breadth of labyrinthine region of periotic	21.3

MEASUREMENTS OF TEETH.

	Last lower molar, right (pl. 7, fig. 1).	Second upper molar, left (pl. 7, fig. 2).	Second lower molar, right (pl. 7, fig. 3).	Second upper molar, right (pl. 7, fig. 4).	Fourth upper pre- molar, left (pl. 7, fig. 5).	Third lower pre- molar, right (pl. 7, fig. 6).	Fourth lower pre- molar, right (pl. 7, fig. 7).
Total length in a straight line (apex of crown to tip longest root as preserved).....	mm. 33	mm. 47.7	mm. 58.8	mm. 52+	mm. 52.2	mm. 45+	mm. 63.4
Length of crown.....	21.6	23.6	22	22±	17.7	17.4	16.7
Greatest diameter of tooth below crown.....	23.2	21.2	21.7	20.2	17.3	16.7	16.5
Greatest height of crown in straight line.....	13.7	20.8	21.9	21.3	19.5	19.6	19.9
Greatest breadth of crown.....	9.6	12	10.5	11.7	10.2	9.6	9.5

	Lower canine (pl. 8, fig. 1).	Upper incisor (pl. 8, fig. 2).	Upper incisor (pl. 8, fig. 3).	Upper incisor (pl. 8, fig. 4).
Total length in a straight line (apex of crown to tip longest root as preserved).....	mm. 90.5	mm. 78.3	mm. 74	mm. 75+
Length of crown.....	14.6	15±	13.5	16±
Greatest height of crown in straight line.....	27	26.6	26	26
Greatest breadth of crown.....	10.2	10.3	10.2	10.5
Greatest diameter of tooth below crown.....	14.5	14.6	13.5	14.4

MEASUREMENTS OF ULNA.

	mm.
Greatest length of ulna	100
Transverse diameter of ulna at lower margin of greater sigmoid cavity	25
Antero-posterior diameter of ulna at lower margin of greater sigmoid cavity	55.6
Transverse diameter of olecranon	14
Transverse diameter of ulna at distal end	17.7
Antero-posterior diameter of ulna at distal end	29.5+

MEASUREMENTS OF VERTEBRAE.

	Anterior dorsal.	Elev- enth dorsal.	First lum- bar.	Second lum- bar.
Greatest depth (vertically) of vertebra as preserved (tip of neural spine to inferior face of the centrum).....	mm. 133	mm. 136	mm. 134	mm. 134
Greatest breadth of spinal canal posteriorly.....	39	23.5	21	25
Greatest depth of spinal canal anteriorly	38	31	35.5	38
Median depth of spinal canal posteriorly	41	30.5	42	38
Depth of centrum posteriorly.....	36.5	45.3	49	53
Breadth of centrum posteriorly.....	55	57	61	68
Length of centrum without epiphyses.....	37	51	58	60
Distance across vertebrae between tips of the transverse processes (parapophyses).....	X	79+	184	178
Distance across vertebrae between tips of prezygapophy- ses (external measurements).....	X	31.5	X	X
Vertical height of neural spine as preserved (distance between superior margin spinal crest and tip of spine).....	57	60	48.5	46.5
Distance across vertebrae between tips of the diapophy- ses as preserved	104+	X	X	X
Distance between tip of right postzygapophysis and tip of right prezygapophysis.....	X	78	X	X
Minimum length of neuropophysis.....	38	34	35.5	42
Antero-posterior breadth of neural spine in a horizontal line immediately above the zygapophyses.....	45	57	52	57

REMARKS ON AN UNDETERMINED SQUALODONT OF LARGE SIZE
FROM THE CALVERT CLIFFS, MARYLAND.SQUALODON, *species indeterminate*.

In the course of several years desultory collecting along the Calvert Cliffs a number of interesting cetaceans have been found. The late F. W. True instigated most of the collecting and encouraged William Palmer and David B. Mackey to make trips along the western shore of Chesapeake Bay. No systematic search was ever made for cetacean remains, but, nevertheless, in this way a miscellaneous collection of fossil cetaceans was built up. A number of skulls in a fair state of preservation were thus obtained, and, in addition to these, large numbers of unassociated vertebrae and teeth. In sorting over this material a number of fragments that pertain to at least two types of squalodonts were found. The smaller one of these is apparently the same as the species described in the present paper. The other represents a larger form which may possibly belong to a previously described squalodont, and in want of more complete material the writer has deferred naming the specimen. In view of the scarcity of squalodonts in North American Tertiary deposits it seems advisable to describe and figure some of the fragments and teeth which have been found. It has been known for some time that a large squalodont existed during the Calvert Miocene, but until recently all that was known concerning it consisted of a few broken teeth. In 1908 a double-rooted molar tooth of large size, but lacking most of the crown, was found adhering to a fragment of the maxilla by Mr. Mackey. This tooth and the other fragments hereinafter described were acquired by purchase from Mrs. W. Palmer.

Specimen, No. 10694, Division of Vertebrate Palaeontology, United States National Museum.—The material consists of one molar and a fragment of a maxilla.

Occurrence.—One mile south of Chesapeake Beach, Calvert County, Maryland, near latitude $38^{\circ} 40'$ and longitude $76^{\circ} 32'$; shown on Patuxent Quadrangle or Patuxent Folio, No. 152, United States Geological Survey.

Horizon.—This specimen was collected by David B. Mackey on July 4, 1908. It was found in the water in freshly fallen beach talus débris which, apparently, was derived from Shattuck's zone 10 of the Calvert Miocene formation of Maryland.

This large two-rooted molar is characterized by swollen roots which have a thick outer layer of cementum that flakes off when subjected to erosion. This layer is thickest near the tips of the roots and becomes thinner near the enamel crown. The dentine of the anterior root is exposed on the external side (pl. 17, fig. 1b); it is dark brown in color. The posterior root was accidentally broken and the

cross section shows a solidified core or tooth pulp perforated by a minute channel for the nerve. In this section the cementum and the dentine are approximately equal in thickness while the diameter of the pulp cavity is fully twice the width of either of the above layers.

The roots are joined at the base by a short thin isthmus which is continued upward as a well-defined groove and terminating below the crown. The posterior root is stouter than the anterior. The enamel crown of the molar is ornamented with longitudinal striae; these striae are more pronounced on the external margin than on the internal. The apex of the crown is missing and the posterior cutting edge is incomplete. The worn surfaces of the enamel indicate that three cusps were originally present on the posterior edge though they were worn down to their bases. The anterior cutting edge is missing.

The fragment of the jaw (pl. 17, fig. 1c) which held this molar is so worn that little information can be obtained regarding its former appearance. It possesses two alveolae for two-rooted molars. The curvature of the outer surface of this fragment suggests that it may be a portion of the left maxilla.

MEASUREMENTS FOR MOLAR AND FRAGMENT OF JAW.

	mm.
Greatest length of crown.....	29
Greatest breadth of crown.....	15. 2
Greatest diameter across combined roots below crown.....	36. 3
Greatest thickness of posterior root.....	17. 7
Greatest width of posterior root.....	18. 5
Length of posterior root measured in a straight line from center of base of crown to tip.....	60. 5
Length of anterior root measured in a straight line from center of base of crown to tip.....	58
Distance from base of enamel crown to outer edge of alveolae.....	15
Greatest length of fragment of jaw.....	94
Greatest depth of fragment of jaw.....	39

A nearly perfect crown of a large molar (pl. 17, figs. 2a, 2b) was obtained by William Palmer on one of his trips to Chesapeake Beach. Reference is made to a number of broken molar teeth in Mr. Palmer's notes, but the teeth are not described in such a way that one can identify them. According to these notes all the teeth were obtained from beach débris and hence there is no means of associating the specimens with any particular zone.

Specimen, No. 10726, Division of Vertebrate Palaeontology, United States National Museum.

Occurrence.—Chesapeake Beach, Calvert County, Maryland.

The molar crown is high and the enamel is rugose, the striae being coarser at the base than at the apex. There are three accessory cusps on the posterior edge. The anterior edge is missing but there are no peculiarities which would suggest the existence of accessory

cusps. The external layer of cementum has flaked off and the exposed dentine is black in color.

MEASUREMENTS FOR THE MOLAR.

	mm.
Greatest length of crown.....	30.7
Greatest breadth of crown.....	14.4
Greatest height of crown (as preserved).....	25.

In 1916 Mr. Palmer found a number of fragments of this large squalodont a few days after a hundred tons or more of the cliff had fallen on the beach. A manuscript note of Mr. Palmer found with the fragments states that rough weather prevented three further attempts to examine the talus material. He thought it was probable that more of the skeleton was present as most of the fractures were recent and it indicated that the skull was broken up by the fall.

Specimen, No. 10695, Division of Vertebrate Palaeontology, United States National Museum.—This material consists of 20 fragments of a skull and mandible; a total of 17 alveolae can be counted in the fragments of the upper and lower jaws. Four teeth were found in the beach débris in the immediate vicinity of these fragments.

Occurrence.—On the western shore of Chesapeake Bay, near South Chesapeake Beach, Calvert County, Maryland, near latitude $38^{\circ} 40'$ and longitude $76^{\circ} 32'$; shown on Patuxent Quadrangle or Patuxent Folio, No. 152, United States Geological Survey.

Horizon.—The fragments were discovered by William Palmer during March, 1916. They were found on the shore at the water edge of a freshly fallen talus and were evidently from the upper brownish part of the cliff, or near the top of Shattuck's zone 9. The top of zone 9 has been considerably eroded at this point. Shattuck's zone 10 is quite different in appearance, and thus the fragments may be assigned to zone 9 of the Calvert Miocene formation of Maryland.

Notwithstanding the small size of this tooth (pl. 18, figs. 1a, 1b) there appears to be some justification for assuming that it belongs to the same type of squalodont as the molar discussed above. The base of the enamel crown is coarsely striate and the root is proportionately stouter than similar teeth of *Squalodon calvertensis*. The proportions of the tooth, the shape, curvature, and appearance of the enamel crown are in no way suggestive of *Squalodon calvertensis*.

MEASUREMENTS FOR THE PREMOLAR.

	mm.
Greatest length of crown.....	15.6
Greatest breadth of crown.....	9.2
Greatest length of tooth (as preserved) measured in a straight line	64.7

A distal fragment of the left maxilla possessing three single-rooted alveolae suggests a long slender rostrum for this squalodont. The fragment is subtriangular in cross section. On the internal side (pl. 18, fig. 3a) and slightly above the palatal face there is a distinct

groove which presumably receives the anterior extension of the vomer. Above this groove the surface slopes obliquely upward and the roughened surface of this face indicates the line of contact with the premaxillae.

MEASUREMENTS FOR THE FRAGMENT OF MAXILLA.

	mm.
Length of fragment of maxilla.....	178.7
Breadth of fragment of maxilla at anterior end.....	35
Breadth of fragment of maxilla at posterior end.....	35.6
Depth of fragment of maxilla at posterior end.....	37
Antero-posterior diameter of first alveolus.....	29
Transverse diameter of first alveolus.....	18.2
Antero-posterior diameter of septum between first and second alveolae.....	19.2

Alveolae for seven teeth, four of which were two-rooted and three one-rooted, are present in the fragment of the left mandible (pl. 19, fig. 1a). The roughened internal surface of the ramus indicates a very long symphysis which terminated proximally near the alveolus for the third two-rooted tooth. An examination of the alveolae shows that the first and second alveolae contained single-rooted teeth, while the third at the time of discovery possessed a crownless tooth. This premolar was two-rooted, but the roots, with the exception of the tips, were joined throughout their length by a thin isthmus. Impressions made by maxillary teeth are to be observed between the alveolae for the posterior premolars. In the alveolae for the first and second two-rooted teeth, the septa which fit between the roots begin at least 7 mm. below the level of the superior face of the ramus, while those in the posterior alveolae extend the full length. On the external face of the mandible there are six foramina opening into the channels that lead anteriorly (pl. 19, fig. 1b). The more anterior foramina are nearer the inferior margin, while the posterior ones approximate the superior margin.

MEASUREMENTS FOR THE FRAGMENT OF MANDIBLE.

	mm.
Length of fragment of mandible.....	367
Vertical depth of proximal end of fragment.....	58
Vertical depth of distal end of fragment.....	41.5
Vertical depth of fragment near center.....	50
Length of perfect septum.....	22

The squamosal is not complete but what is preserved exhibits some unusual features. In its general form, the squamosal resembles other previously described squalodonts; the massive zygomatic process and the relatively small glenoid fossa are suggestive of *Squalodon bariensis*. It differs, however, in many respects from that species. The zygomatic process is stout, tapering anteriorly as seen from the dorsal view, but rather deep dorso-ventrally. The superior margin does not rise abruptly above the exoccipital and presents an irregular outline. The postglenoid process is a strong ventrally projected plate

of bone whose posterior face is grooved by the external auditory meatus and whose anterior face is continuous with the glenoid fossa. The process is rather broad and terminates in a rounded tip.

When viewed from the ventral side (pl. 20, fig. 1a) the glenoid surface is seen to be strongly concave antero-posteriorly and rather narrow from side to side. On the internal and posterior margin of the glenoid fossa there is a shallow cavity measuring approximately 25 by 48 mm., the function of which is uncertain. A third low knoblike process fills in the space between the groove for the external auditory meatus and the exoccipital.

MEASUREMENTS FOR THE SQUAMOSAL.

	mm.
Distance from tip of zygomatic process to tip of postglenoid process.....	141
Distance from tip of zygomatic process to posterior margin of exoccipital.....	184
Greatest breadth of glenoid surface.....	53
Greatest length of glenoid surface.....	100+

The exoccipital varies greatly in thickness, being massive at the ventro-external border and thin superiorly. The superior margin (pl. 20, fig. 1b) is deflected backward and presumably represents the external projection of the lambdoidal crest which follows the curvature of the temporal fossa. Externally the exoccipital is suturally united with the squamosal, the remainder is free, and forms the posterior wall of the periotic recess. A large paroccipital process is formed by the ventral expansion of that portion of the exoccipital adjacent to the knoblike process of the squamosal.

FRAGMENT OF A RIGHT MAXILLA.

Among these fragments is a portion of a right maxilla (pl. 18, fig. 2). In its general form the maxilla was undoubtedly much like the corresponding element in the skull of *Squalodon calvertensis*. Two double-rooted alveolae are present, and these are too small to bear teeth as large as those of the large squalodont discussed previously. The fragments collected by Palmer do not bear any collector's numbers, and it is possible that this fragment of the maxilla was at some time accidentally placed in the tray containing the larger specimen.

EXPLANATION OF PLATES.

Squalodon calvertensis, new species. No. 10484, Division of Vertebrate Paleontology, U. S. National Museum. Calvert formation, western shore of Chesapeake Bay, about 2 miles south of Chesapeake Beach, Calvert County, Maryland. Collected by Norman Boss July 8, 1921.

PLATE 1.

Type skull of *Squalodon calvertensis*, new species. About two-fifths natural size. Dorsal view. The superior margin of the mesethmoid is imperfectly preserved and has been restored in the figure.

The same abbreviations are used on Plates 1 to 4 for the following parts: *Al.*, alisphenoid; *Bo. pl.*, descending free plate of basioccipital; *Bs.*, basisphenoid; *C.*,

condyle; *Can. op.*, canalis opticus; *Cr. l.*, lambdoidal crest; *Ex. o.*, exoccipital; *Fo. c.*, condylar foramen; *Fo. lac. med.*⁸⁴, foramen lacerum medium; *Fo. lac. post.*, foramen lacerum posterius; *Fo. m.*, foramen magnum; *Fr.*, frontal; *Fs. petr.*, fossa petrosi; *Gl. f.*, glenoid fossa; *La.*, lachrymal; *M.¹-M.⁷*, first to seventh molars, inclusive; *Max.*, maxilla; *Meat. aud. ext.*, meatus auditorius externus; *Mes.*, mesethmoid; *N. A.*, external openings of nasal passages; *Na.*, nasal; *Pa.*, parietal; *Pa. p.*, paroccipital process; *Pm.³-Pm.⁵*, third to fifth premolars, inclusive; *Pmx.*, premaxilla; *Po. gl. p.*, postglenoid process; *Po. p.*, postorbital portion of supraorbital process of frontal; *Pr. falc.*, processus falciformis; *Pr. p.*, preorbital portion of supraorbital process of frontal; *Prs.*, the posterior end of the presphenoid is exposed in this open suture in front of the basisphenoid; *Pt.*, external pterygoid; *So.*, supraoccipital; *Sph. f.*, sphenoidal fissure; *Sq.*, squamosal; *Vo.*, vomer; *X.*, internal openings of nasal passages were present at this point originally, but were not preserved in this skull—the region they would occupy having been filled in with plaster of Paris.

PLATE 2.

Type skull of *Squalodon calvertensis*, new species. About two-fifths natural size. Ventral view.

PLATE 3.

Type skull of *Squalodon calvertensis*, new species. About two-fifths natural size. Lateral view. The parieto-squamosal and parieto-frontal sutures indicated in this figure represent the relations existing between these elements on the left lateral wall of the cranium.

PLATE 4.

Type skull of *Squalodon calvertensis*, new species. About two-fifths natural size. Posterior view.

PLATE 5.

Type mandible of *Squalodon calvertensis*, new species. About seven twenty-fifths natural size. Fig. 1a, external view; Fig. 1b, superior view.

PLATE 6.

FIG. 1. Type mandible of *Squalodon calvertensis*, new species. About seven twenty-fifths natural size. Internal view.

2. Right ulna of *Squalodon calvertensis*, new species. About twenty-one twentieths natural size. External view.

PLATE 7.

Teeth of *Squalodon calvertensis*, new species. About natural size. Fig. 1, posterior lower molar, right side; Fig. 2, second upper molar, left side; Fig. 3, second lower molar, right side; Fig. 4, second upper molar, right side; Fig. 5, fourth upper premolar, left side; Fig. 6, third lower premolar, right side; Fig. 7, fourth lower premolar, right side.

PLATE 8.

Four teeth and a right periotic of *Squalodon calvertensis*, new species. About natural size. Fig. 1, lower canine ?; Figs. 2-4, upper incisors ?; Fig. 5, ventro-internal view of periotic; Fig. 6, internal view of periotic.

PLATE 9.

Anterior dorsal vertebra of *Squalodon calvertensis*, new species. About one-half natural size. Fig. 1, anterior view; Fig. 2, superior view; Fig. 3, posterior view.

⁸⁴The line leading from *Fo. lac. med.* on plate 2 terminates at an opening which may represent the foramen ovale; it should have been continued inward for 3. mm. or more to a smaller foramen.

PLATE 10.

Eleventh dorsal vertebra of *Squalodon calvertensis*, new species. About nine-sixteenths natural size. Fig. 1, anterior view; Fig. 2, superior view; Fig. 3, posterior view.

PLATE 11.

First lumbar vertebra of *Squalodon calvertensis*, new species. About five-ninths natural size. Fig. 1, anterior view; Fig. 2, posterior view.

PLATE 12.

Second lumbar vertebra of *Squalodon calvertensis*, new species. About five-ninths natural size. Fig. 1, anterior view; Fig. 2, posterior view.

PLATE 13.

Vertebrae of *Squalodon calvertensis*, new species. About five-ninths natural size. Fig. 1, superior view of first lumbar vertebra; Fig. 2, superior view of second lumbar vertebra; Figs. 3-4, epiphyses of vertebrae. Internal views. About natural size.

PLATE 14.

Figs. 1-2. Epiphyses of vertebrae. Internal views. About natural size.

PLATE 15.

Figs. 1-2. Epiphyses of vertebrae. Internal views. About natural size.

PLATE 16.

Ribs of *Squalodon calvertensis*, new species. About seven-twentieths natural size. Fig. 1, first rib, left side; Fig. 2, second rib, left side; Fig. 3, third rib, left side; Fig. 4, fifth rib, left side; Fig. 5, sixth rib, left side; Fig. 6, eleventh rib, left side; Fig. 7, sixth ? rib, right side; Fig. 8, fourth rib, right side; Figs. 9-10, posterior ribs, right side.

PLATE 17.

Figs. 1a, 1b. Molar tooth of *Squalodon*, species undetermined. About natural size. Fig. 1c, fragment of jaw. About seven-ninths natural size. No. 10694, Division of Vertebrate Paleontology, U. S. National Museum. Calvert formation, 1 mile south of Chesapeake Beach, Calvert County, Maryland.

2a, 2b. Molar tooth of *Squalodon*, species undetermined. About natural size. No. 10726, Division of Vertebrate Paleontology, U. S. National Museum. Chesapeake Beach, Calvert County, Maryland.

PLATE 18.

Figs. 1a, 1b. Premolar tooth of *Squalodon*, species undetermined. About natural size. Fig. 2, fragment of right maxilla. About thirteen-twentieths natural size. Figs. 3a, 3b, fragment of left maxilla. About three-fifths natural size. No. 10695, Division of Vertebrate Paleontology, U. S. National Museum. Calvert formation, near South Chesapeake Beach, Calvert County, Maryland.

PLATE 19.

Figs. 1a, 1b. Fragment of left mandible of *Squalodon*, species undetermined. About two-thirds natural size. No. 10695, Division of Vertebrate Paleontology, U. S. National Museum. Calvert formation, near South Chesapeake Beach, Calvert County, Maryland.

PLATE 20.

Figs. 1a, 1b. Left squamosal and adjoining exoccipital of *Squalodon*, species undetermined. About six-tenths natural size. No. 10695, Division of Vertebrate Paleontology, U. S. National Museum. Calvert formation, near South Chesapeake Beach, Calvert County, Maryland.